Bioassessment Program for Wadeable Streams and Rivers
Program Documents

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Willow Creek, East Humboldt Range
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ACRONYMS and ABBREVIATIONS

µm	Micrometer(s)
4WD	Four Wheel-Drive
ABP	Annual Bioassessment Plan
AFDW	Ash-Free Dry Weight
AIS	Aquatic Invasive Species
BMI	Benthic Macroinvertebrate
BWQP	Bureau of Water Quality Planning
cm	Centimeter(s)
COC	Chain of Custody
Coordinator	Bioassessment Program Coordinator
CPR	Cardiopulmonary Resuscitation
CWA	Clean Water Act 1972
DBH	Diameter at Breast Height
DBI	Diatom Bioassessment Index
DI	Deionized Water
DO	Dissolved Oxygen
DQA	Data Quality Assessments
DQR	Data Quality Review
EDAS	Ecological Database Application System
EPA	Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning Systems
HDPE	High-density polyethylene
L	Liter(s)
m	Meter(s)
mL	Milliliter(s)
mm	Millimeter(s)
MMI	Multimetric Index

MQO	Measurement Quality Objectives
NAC	Nevada Administrative Code
NAD	North American Datum
NARS	National Aquatic Resource Survey
NDEP	Nevada Division of Environmental Protection
NIST	National Institute of Standards and Technology
NLA	National Lakes Assessment
NRS	Nevada Revised Statute
NRSA	National Rivers and Streams Assessment
NWCA	National Wetland Condition Assessment
O/E	Observed to Expected
ORD	Office of Research and Development
PHab	Physical Habitat
Program	Bioassessment Program
QA	Quality Assurance
QAPrP	Quality Assurance Program Plan
QC	Quality Control
SOP	Standard Operating Procedure
State	State of Nevada
TMDLs	Total Daily Maximum Loads
TSA	Technical System Audit
USGS	United State Geological Survey
WQS	Water Quality Standards
WQSAM	Water Quality Standards, Assessment, and Monitoring

1 BIOASSESSMENT PROGRAM STATEMENT

The mission of the Nevada Division of Environmental Protection (NDEP) is to protect and enhance the environment of the State of Nevada (hereafter known as the State) in order to protect public health, sustain healthy ecosystems, and contribute to a vibrant economy. One of the ways that the Bureau of Water Quality Planning (BWQP) accomplishes this mission is by implementing the Bioassessment Program. The purpose of the Bioassessment Program (hereafter known as the Program) is to conduct bioassessments, develop tools to assess the ecological integrity of surface waters, and to collect biological information for developing water quality criteria in the State. The general authority for the Program comes from the objective statement in Section 101(a) of the Clean Water Act (CWA): to restore and maintain the chemical, physical and biological integrity of the nation's waters. Legal authority also comes from Section 303(c)(2)(B) which requires states to adopt numeric water quality criteria for toxic pollutants for which the United States Environmental Protection Agency (EPA) has published criteria as well as water quality laws and regulations contained in the Nevada Revised Statutes (NRS) 445A.300 - 445A.730 and Nevada Administrative Code (NAC) 445A.070-445A.2234. The Program has been developed following EPA guidance (Barbour *et al*., 1996. USEPA 2007).

Since 2000, the Program has conducted annual bioassessments to evaluate on the ecological integrity of Nevada's wadeable streams and rivers. Ecological integrity can be defined as the capability of a surface water to support and maintain a balanced, integrated adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitat of the region. It is determined by monitoring the biological condition, water quality, and physical habitat (Figure 1) (Karr 1993). Assessing biological condition of a waterbody includes analyzing the community composition of benthic macroinvertebrates (BMI) and periphyton as well as documenting the condition of the riparian habitat.

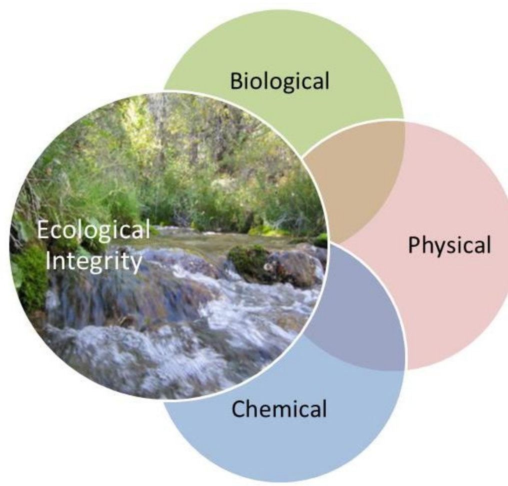

Figure 1: Influences of attributes in bioassessment samplings.

Evaluating water quality includes *in-situ* measurements of dissolved oxygen (DO), pH, conductivity and water temperature as well as independent laboratory analysis of water column chemistry. Delineating the physical habitat includes assessing stream channel characteristics such as substrate, bank stability, depth and flow. All three of the above indicators, biological condition, water quality, and physical habitat, are integral in the evaluation of the overall ecological integrity of Nevada's wadeable streams and rivers

1.1 Bioassessment Program Objectives

As described in the Annual Bioassessment Plan (ABP), and in coordination with the BWQP and other interested parties (agencies, conservation organizations and citizens), the Program establishes priorities for bioassessments throughout the State. These bioassessments are performed in accordance with standardized protocols that are described in the Standard Operating Procedures (SOP) found in Appendix A. The Program intends to achieve the following four objectives:

- Evaluate, through monitoring, the biological condition, water quality, and physical habitat of wadeable streams and rivers throughout the State. This is accomplished through the comparisons of probabilistic, reference, targeted and repeat site data and conditions.
- Support the development of water quality standards (WQS) and total maximum daily loads (TMDLs) through bioassessments. This is accomplished by collaborative efforts with the Standards and Monitoring program through routine assessments, expanded surveys and special investigative projects as designed by the BWQP staff.
- Investigate through bioassessments streams and rivers of concern, identified by the BWQP's 303(d)/305(b) Integrated Report and/or interested parties, to evaluate if WQS and beneficial uses are being met and to determine if ecological integrity indices confirm or refute areas of concern. This is accomplished by performing one or more bioassessments of the site of concern, corroborating WQS, determining the progress of TMDLs and utilizing the results to determine a causal analysis of impairment (if present).
- Document and describe, through data analysis, data maintenance and reporting, the condition of Nevada's wadeable streams and rivers. This is accomplished by the analysis of field data, independent analytical results of water chemistry, benthic macroinvertebrates and periphyton, and consolidating collected information into reports and presentations for internal and external parties.

1.2 Bioassessment Program Organization

The Program is administered by the Bioassessment Program Coordinator (hereafter known as the Coordinator) whose efforts are supervised by the Supervisor, WQS, Assessment and Monitoring Branch (WQSAM) and Bureau Chief, Water Quality Planning (Table 1). As required, the Coordinator, Supervisor, and Bureau Chief meet to discuss, review and approve the ABP including EPA grant applications, contracts with independent analytical and taxonomic laboratories, and other Program needs. The Coordinator, under the direction of the Supervisor and Bureau Chief, conducts an annual recruitment and hiring of seasonal interns to assist in field assessments. Additionally, the Coordinator is responsible for developing and initiating Requests for Quotes from independent taxonomic laboratories for BMI and periphyton identification and enumeration. The Coordinator regularly communicates with the BWQP Management Analyst to ensure grant funds are expended in the time-frames as indicated by contracts with other agencies and organizations. As needed, the Coordinator may assist other BWQP programs.

Table 1: Functions, roles and responsibilities of the Bioassessment Program.

Function	Role/Responsibility
Bureau Chief, Water Quality Planning	• Has the overall responsibility for direction, and any changes, in the scope of work for the Program. The Bureau Chief will also oversee scheduling and management of all technical and non-technical aspects of the program.
Supervisor, Water Quality, Standards, Assessment and Monitoring	• Will ensure that all aspects of the program meet QA/QC objectives. This includes review of documents, reports, plans, schedule and communications, directs and reviews QA/QC plans, Annual Sampling Plans (ASPs) and trains personnel on QC requirements. This position is independent of direct data generation activities.
Bioassessment Program Coordinator	• Responsible for Program implementation and those technical and scheduling objectives are achieved successfully. Coordinates all Program activities and provides technical guidance to staff and management. Will be the primary point of contact for the Program. • Responsible for data processing, database development and management, and data QC throughout the data analysis process. • Responsible for all aspects of document production including data interpretation, internal and external technical reviews, editing and publishing documents.
Seasonal Field Crews	• Responsible for completion of assigned biological field and database entry duties with strict adherence to the Bioassessment SOP.
Contract Independent Analytical and Taxonomic Laboratories (3)	• Processes water chemistry samples, performs QC evaluations of adherence to laboratory SOPs, and produces analytical laboratory reports. • Processes BMI samples, determines taxonomic identifications of specimens, records taxonomic names and abundances on bench sheets and in a database, performs QC evaluations of adherence to laboratory SOPs and produces laboratory reports. Performs secondary QA/QC of previously identified periphyton. • Processes periphyton samples, determines taxonomic identifications of specimens, records taxonomic names and abundances on bench sheets and in a database, performs QC evaluations of adherence to laboratory SOPs, and produces laboratory reports. Performs secondary QA/QC of previously identified BMIs.

Additionally, the Program may coordinate with other branches of the BWQP and adheres to all documents therein including the Nevada Continuing Planning Process for BWQP, the BWQP Long Range Plan and the Nevada Quality Assurance Program Plan for Surface Water Sampling (NDEP 2014), which are available upon request from the BWQP Supervisor, WQSAM.

1.3 Bioassessment Program Documents

The Program is supported by two documents contained herein which support the design, implementation and data management of the Program: the Quality Assurance Program Plan (QAPrP) and the Standard Operating Procedures (SOP). Both documents are reviewed and updated as necessary in response to the needs and deliverables of the Program.

The purpose of the QAPrP is to define the data and measurement quality objectives necessary to support the Program and all indicators noted. Additionally, it is to document quality assurance (QA), quality control (QC) procedures, and other technical activities to be implemented to ensure that the results of the Program operations are of the type and quality required for use by the State and EPA. The QAPrP will provide sufficient detail to demonstrate that:

- The Program's technical and quality objectives are identified and agreed upon;
- The intended measurements, data generation, and data acquisition methods are appropriate for achieving Program objectives;
- Assessment and review procedures are sufficient for confirming that data of the type and quality needed are obtained; and
- Any limitations on the use of the data will be identified and documented.

The development, review, approval, and implementation of the QAPrP are part of EPA's mandatory Quality System (USEPA 2001).

The SOP describes field protocols and daily operations for field crews to use for wadeable stream and river bioassessments and is designed to reference how field crews will collect the biological, chemical and physical information needed to assess the condition of the State's wadeable streams and rivers. The SOP is not exclusive of annual in-field training of BWQP personnel, field crews and seasonal interns, but is a detailed description of field protocols and other considerations that may arise during a bioassessment.

In the event that the Program is participating in an EPA sponsored National Aquatic Resource Survey (NARS), the applicable field operations manual, quick reference guide, and QAPP are in effect, including protocols and standards from EPA Region 9 sponsored training for Program staff and/or field leads. Additionally, the NDEP BWQP Standards and Monitoring Water Chemistry SOPs and QAPrP are referenced when necessary.

1.4 Annual Bioassessment Plan

An ABP is developed for the index period, which is generally mid-May through mid-September. Sampling may occur during other times of the year as necessary or requested. The ABP is developed to coincide with the five-year rotating cycle of National Aquatic Resource Surveys (NARS) as designed by the EPA. The Program participates in the portion of the NARS cycle that includes rivers and streams, lakes, and wetlands; however, not the coastal condition assessment. The National Rivers and Streams Assessment (NRSA) is generally a two index period event (over the course of two summers), while the National Wetland Condition Assessment (NWCA) and the National Lakes Assessment (NLA) occur separately in a single index period each. In addition to participating in the NARS when applicable, the Program conducts state-specific stream and river bioassessments. Depending on hydrologic conditions, site availability, and previous commitments, it is anticipated that 30 to 50 Nevada-specific sites will be bioassessed during an index period in addition to the NARS participation. Additionally, the ABP outlines field training and other professional development opportunities that enhance the quality of the Program.

1.4.1 Site Definition and Selection

Wadeable stream and river bioassessment sites include probabilistic, reference, targeted impaired, and repeat sites. During an index period, each classification will be sampled and sites are determined during the ABP review. Sites are desk-top evaluated for access, waterbody channel and conformity to the Program's goals and objectives. Methods of desk-top evaluation include determination of property ownership through county assessor websites and databases, utilizing Global Information Systems (GIS) programs to assess channel characteristics and safe access. Where necessary, a field reconnaissance may be performed to better determine site suitability.

1.4.1.1 Probabilistic

Probabilistic sites are randomly selected sites throughout the State that, in aggregate, are a statistical representation of the ecological status of the State's streams and rivers. During the ABP site selection, probabilistic sites are evaluated and selected in a sequential manner from the master list without bias to the site. The master list of probabilistic sites includes sites specifically developed for the State by the EPA's Office of Research and Development (ORD), Western Ecology Division, and remaining oversample lists from previous NRSA. It is the intent that a minimum of fifteen probabilistic sites are bioassessed per index period.

1.4.1.2 Reference

Reference sites are streams and rivers that are considered as close to natural or historical conditions as possible prior to any human disturbance activities. Generally, reference sites have minimal disturbance within the watershed and are in the best attainable condition possible. The Program's reference sites were selected by the EPA's ORD, Western Ecology Division and the Western Center for Monitoring and Assessment of Freshwater Ecosystems (Utah State University), in addition to BWQP suggested sites based on best professional judgment and field experience. The results from reference bioassessment sites are used as benchmarks of ecological integrity.

1.4.1.3 Impaired

Sites considered impaired are selected from the NDEP BWQP 303(d) list for water column chemistry impairment, BWQP personnel best professional judgment or previously sampled sites that had impaired predictive modeling scores. The purpose of sampling 303(d) sites is to determine if the biology, specifically the BMIs and periphyton, are influenced by the particular chemical constituent that leads to 303(d) listing or to determine if there have been changes to the biological community since the previous sampling(s).

1.4.1.4 Repeat

Repeat sites are sites that since the inception of the Program have been regularly bioassessed. Repeat sites may be reference, probabilistic or impaired. The benefit of repeat bioassessments is to determine if there have been changes over time and to decide if the ecological integrity of the site has remained the same, improved or become degraded.

1.4.2 Training

The Coordinator attends conferences and workshops to maintain, attain and ensure the level of professional proficiency required to conduct bioassessments and to analyze and report results. Additionally, the Coordinator attends workshops designed by EPA in support of the applicable NARS series.

All seasonal interns attend an initial NDEP Bioassessment Program training event conducted by the Coordinator and BWQP staff prior to the initiation of the field season. This training covers field methods for collecting and recording biological, chemical and physical data. The training consists of classroom sessions and hands-on training in the field and emphasizes practice of methods, collection of high quality data and safety. Additionally, seasonal interns attend the State's Defensive Driving course, a CPR/First Aid course, and, if applicable, a Boating Safety course. The Coordinator is responsible for ensuring the appropriate program personnel have the most current approved version of the Bioassessment Programing Documents (SOP and QAPrP).

1.5 Purpose and Description of Indicator Measurements

All of the indicators evaluated during bioassessments are related to the overall ecological integrity of the waterbody and when negatively affected, can be a source of limitation to aquatic obligate organisms. Examples of aquatic obligate organisms include BMI, periphyton, aquatic macrophytes, fish, amphibians and other organisms that spend all or part of their life dependent on the aquatic habitat for refuge, foraging, and/or reproduction. Quality of riparian habitat affects the physical and biological processes of a waterbody. Increased canopy cover decreases water temperature thereby creating more favorable habitat for aquatic obligate organisms. An abundance of native shrubs and grasses enhances bank stability thereby reducing erosion. Alterations of the riparian habitat, such as channel modifications, agricultural practices including grazing, streambank modifications/developments, reduce the complexity of the habitat resulting in negative changes to the aquatic community structure and ecosystem degradation.

Ecological indicators based on water chemistry evaluate waterbody condition with respect to stressors such as acidic deposition and other types of physical and chemical contamination. Aquatic obligate organisms have narrow ranges of chemical tolerance. *In-situ* measurements of DO, pH, conductivity, and water temperature can be interpreted as affecting biotic health if measurements are outside of tolerable parameters. Water quality samples are a snapshot-in-time that with additional collections may be tracked to determine if changes, either positive or negative, have occurred in nutrient levels, metals, and other indicators. Data from water chemistry results can include the acid-base status of the site, turbidity, and trophic status based on nutrient enrichment.

1.5.1 Benthic Macroinvertebrate (BMI) Assemblage

Benthic macroinvertebrates (BMI) are benthic (bottom-dwelling) organisms that are large enough to be seen without magnification. Examples of BMI include crayfish, snails, clams, aquatic worms, leeches, and the larval and nymph stages of many insects, including dragonflies, mosquitoes, and mayflies. Populations in the benthic assemblage respond to a wide array of stressors in different ways so that it is often possible to determine the type of stressor that has affected a BMI assemblage based on the taxa present.

The BMI assemblage found in substrates of streams are an excellent indicator for evaluating the ecological integrity of streams and rivers due to their life history strategies. The response of BMI communities to various stressors can determine the type of stressors and monitor trends in ecological integrity. BMIs have low mobility so they are unable to escape water quality stressors thereby both integrating stressors over time and responding to cumulative stressors. Due to their relatively short lifespans (generally weeks to months with few exceptions), BMIs respond to recent stressor events. A community of BMIs can be diverse with individual species responding differently to stressors providing a gradient of stressor magnitude.

1.5.2 Periphyton

Periphyton are diatoms and soft-bodied algae that are attached or otherwise associated with channel substrates. Like BMIs, periphyton are excellent indicators of the ecological integrity of streams. As primary producers, periphyton are directly affected by chemical and physical factors influencing streams and rivers. They can contribute to the physical stability of substrate particles and provide habitat and structure. Periphyton are useful indicators of environmental conditions because they respond rapidly and are sensitive to a number of anthropogenic disturbances that other organisms may not respond to, or respond to only at differing concentrations, e.g., contamination by nutrients, metals, herbicides, hydrocarbons and acidification.

1.5.3 Water Quality Measurements

Measurements performed *in-situ* for DO, pH, conductivity, and water temperature are taken with a calibrated multiparameter sonde at each site. This information is used to detect extremes in condition that might indicate impairment. In addition, water chemistry samples are collected, analyzed by an independent laboratory, and may be used to determine the classification of water chemistry type. These samples include analysis for routine pollutants, nutrients, metals and bacteria. Samples are collected in accordance of Nevada Quality Assurance Program Plan for Surface Water Sampling (NDEP 2014).

1.5.4 Physical Habitat Assessment

The physical habitat assessment of the stream or river and the riparian zone (the region immediately adjacent to the stream or river) serves three purposes. First, habitat information is essential to the interpretation of what ecological condition is expected to be like in the absence of many types of anthropogenic impacts. Second, the habitat evaluation is a reproducible, quantified estimate of habitat condition, serving as a benchmark against which to compare future habitat changes that might result from anthropogenic activities. Third, the specific selections of habitat information collected aid in the diagnosis of probable causes of ecological degradation in streams and rivers.

In addition to information collected in the field by the physical habitat assessment, the physical habitat description of each site includes many map-derived variables such as stream order and drainage area. Furthermore, an array of information, including watershed topography and land use, supplements the physical habitat information. Together with water chemistry, the habitat measurements and observations describe the variety of physical and chemical conditions that are necessary to support ecological integrity and foster long-term ecosystem stability.

1.6 Bioassessment Program Data Analysis

The Program is committed to the gathering, establishment, maintenance and availability of high quality data. These objectives are achieved by following the protocols as outlined Program's SOP (gathering), receiving results from independent laboratories for BMI, periphyton and water chemistry (establishment), and performing audits of field activities and data results as defined in the QAPrP (maintenance). The availability of high quality data is achieved through data analysis and reporting of bioassessment results.

Benthic macroinvertebrate and periphyton taxonomic results are analyzed with biological metrics specifically developed for the Program. The Western Center for Monitoring and Assessment of Freshwater Ecosystems developed two separate predictive models that analyze BMI data specifically for Nevada (Vander Laan and Hawkins, 2013. Vander Laan *et al.*, 2013): (1) a multi-metric index (MMI) that measures ecological function and structure, and (2) an observed-to-expected (O/E) that accounts for taxonomic completeness for a specific site. Both of these BMI indexes were based on sites considered reference condition throughout Nevada. A Diatom Bioassessment Index (DBI), based on the Kentucky Diatom Bioassessment Index (Kentucky 2008) and utilizing investigations of metrics performed by the Desert Research Institute (Davis and Fritsen 2006) for the Program, analyses periphyton function and structure. Biological index results are compared to physical and habitat results, i.e., fines and sands as a proportion of substrate, results of water chemistry analysis (both *in-situ* and independent analytical) and human influences (development, agriculture, and other observed attributes).

Bioassessments support and complement the efforts of BWQP and other interested agencies. The compilation and comparison of analyzed data is used to evaluate possible causal sourced of impairment, if present, and to identify streams categorized as reference condition. Long-term datasets, either on an aggregated ecoregion scale or individual stream, inform the selection of streams for the Annual Bioassessment Plan and other special studies. Results of the Program's data analysis are used to further investigations of watershed impairments where appropriate, suggest where non-point source restoration programs may be implemented, development of water quality standards specific to aquatic life beneficial uses, and continued long-term monitoring of repeat sites to determine effects of climatic variations on stream condition. The Coordinator communicates the status of the Program's data analysis through oral and poster presentations at professional association meetings, development and distribution of internal and external reports, and updates to the EPA though quarterly grant reporting and end of the year reviews.

1.7 Report Storage and Retention

Technical reports are housed in the Program's files and archives on the BWQP network drive. Stream Survey Forms are completed during the sampling event and later entered into the main Ecological Database Application System (EDAS) which is maintained on the BWQP network drive. Other Program studies and related WQS research are stored within the Program's files on the BWQP network drive. The field season files containing site information, laboratory reports, stream survey forms, QC forms, COCs, calibration logs, and other materials are physically maintained at BWQP for a period of five years, thereafter documents are secured in the Nevada State Archives. Aforementioned documents are scanned to pdf documents and archived on the BWQP network drive for an indefinite amount of time.

All Program data is made publically available either through the publication of reports available on the BWQP website and/or individual inquiries made to the Coordinator and/or the Supervisor, WQSAM.

1.8 Taxonomic Reference Specimen Collection Storage

The Program contracts with two separate independent laboratories for taxonomic identification. One laboratory processes BMI (identification and enumeration) and conducts QA/QC of periphyton identification performed by the contracted periphyton laboratory. A separate laboratory processes periphyton (identification and enumeration) and conducts QA/QC of BMIs identified by the contracted BMI laboratory. Both laboratories have QAPrPs that conform to the Program's needs and perform internal QA/QC on samples provided. The contracted laboratories' name, staff directory and qualifications, contact information and their respective QAPrPs are available upon request.

The Program receives BMI and periphyton voucher and reference specimens from the taxonomic laboratories and these collections are maintained permanently at the BWQP office. Laboratories responsible for the primary identification of BMI and periphyton create a voucher and reference specimen collection on an annual basis. For BMI voucher and reference specimen collections, taxon are preserved in a glass vial with 70% ethanol containing a paper label which includes taxon name, site identification, stream name, and date collected. Specimens are added when new taxa are encountered, when needed to replace degraded specimens, and to ensure that there is replicate material from different locations around the State. The Coordinator will ensure that the preservative is checked annually and refreshed if needed. The periphyton voucher and reference specimen collection is developed from a digital photograph collection and slide-mounted diatoms. The voucher and reference specimen collection is maintained for several reasons:

- The collection supports all the research and reports produced by the Program;
- To share with other scientific professionals for the purpose of reporting on organismal distribution throughout the State;
- To periodically perform inter-laboratory taxonomy QC checks on the voucher specimens independent of secondary laboratory QA/QC;
- Other laboratories may study the voucher collection for QC purposes; and
- To use the voucher collection for occasional in-house taxonomic identifications, training, and internal study purposes.

2 QUALITY ASSURANCE PROGRAM PLAN

2.1 Definitions and Main Elements

2.1.1 Definitions

Quality Assurance Program Plan (QAPrP): A system of both management and technical activities involving the planning and implementation of annual bioassessments, documenting and assessing field data and laboratory taxonomic results, and reporting on the outcomes. As a result, quality improvement may occur to ensure compliance with the Program's objectives to meet standards.

Quality Assurance (QA): An integrated system of management activities involving planning, implementation and quality improvement to ensure that Program activities are of the type and quality required to meet scientific standards to produce the highest quality data and achieve Program goals.

Quality Control (QC): The system of technical activities that measures the performance of the Program against defined standards.

2.1.2 QAPrP Main Elements

This QAPrP is composed of four main elements covering the entire Program from planning, through implementation, to assessment and review as follows:

- Program Documentation and Description;
- Data Generation and Acquisition;
- Assessment and Responsive Measures ; and
- Data Validation and Usability Elements.

2.2 Program Documentation and Description

2.2.1 Documentation

The QAPrP for the Program will be kept at BWQP. This document will be updated as needed in response to realized Program goals and/or QA/QC audits requiring corrective measures. An ABP will be developed and this QAPrP and the SOP will be referenced as necessary.

2.2.2 Program Description

This QAPrP is intended for wadeable streams and rivers only. Any site which can be categorized as a wetland, canal, or lake/reservoir will be disregarded and the next alternative site will be selected. For sites that are located in another state, that site will be moved along the same stream into Nevada and bioassessd near the state border unless a representative of the respective state is present. To support the continue goals of the Program, the following QAPrP objectives will be sought on an annual basis:

- Ensure that all sampling events are completed using wadeable streams sampling protocols as defined in the SOP; and
- Bioassess probabilistic, repeat, targeted, impaired and reference sites. Included in this effort is at least two but no more than four revisits randomly selected to include duplicate BMI and periphyton samples within 7-10 days of the initial visit. At least one of the revisits will occur within the first two weeks of the field season. These revisits serve as the QA/QC for sampling efforts to reduce bias and increase precision. Immediate results from a QA/QC visit are a >10% difference in physical characteristic assigned value scores as determined by the Coordinator. If a >10% difference in physical characteristics assigned value scores are found between samplings, field performance will be evaluated and corrected as necessary.

2.2.3 Superseding QAPrPs

When the Program is participating in an EPA sponsored National Aquatic Resource Survey (NARS), the appropriate QAPP will apply. All water chemistry sampling follow the Nevada Quality Assurance Program Plan (NDEP 2014) where applicable.

2.3 Data Generation and Acquisition

2.3.1 Program Standard Operating Procedures (SOP)

The Program SOP directs all elements of site activities including characterization of the physical habitat, the collection biological indictors and water chemistry data. Data generated in this effort supports the goals of the Program. The SOP can be found in Appendix A.

2.3.2 Overview of Independent Analytical and Taxonomic Laboratory Operations

The Program collects samples that require analytical analyses by independent laboratories, and in the case of BMI and periphyton samples, a secondary QA/QC analysis. Depending on the sample type, holding times may vary. Water chemistry, fecal bacteria, sediment, chlorophyll-*a* and periphyton biomass as determined by ash-free dry weight (AFDW) require the analytical process as soon as possible after collection. (Sediment, chlorophyll-*a* and AFDW are collected only during special investigative bioassessments.) The designated Nevada certified independent analytical laboratory has agreed to accept water chemistry samples within four days of collection date provided that samples were stored on wet ice and/or in a portable electric cooler. There are no hold times for preserved BMI and periphyton samples and it is understood that a field season’s worth of preserved samples may be delivered to the selected taxonomic laboratory at the conclusion of the field season.

Laboratories selected to provide analytical analysis are expected to have the appropriate facilities and staff to provide the contracted services within the specified delivery timeframe. All contracted laboratories are required to submit to the Program a copy of their QAPrP and SOP(s). The contracted laboratories' name, staff directory and qualifications, contact information and their respective QAPrPs are available upon request.

The designated Nevada certified independent analytical laboratory provides analytical water chemistry, in addition to sediment chemistry, chlorophyll-*a* and periphyton biomass as determined by AFDW. (Sediment chemistry, chlorophyll-*a* and AFDW are collected only during special investigative bioassessments.) Clean Water Act (CWA) and standard methods and guidelines are utilized and referenced. If standard methods are modified and/or experimental methods utilized, these methods will be documented and described in the applicable laboratory's SOP.

Benthic macroinvertebrate and periphyton samples are processed by separate contracted taxonomic laboratories. One contracted laboratory identifies and enumerates BMI samples and conducts a QA/QC of the previous field season's periphyton digital photograph reference collection as created by a separate taxonomic laboratory. The secondary contracted taxonomic laboratory identifies and enumerates periphyton samples and conducts a QA/QC on 10% of the previous field season's BMI samples as processed by the aforementioned laboratory. Taxonomic laboratories are selected on their identification experience including levels of taxonomic certification attained by staff.

2.3.3 Measurement Quality Objectives (MQO)

Measurement quality objectives (MQO) are qualitative and quantitative statements intended to decrease levels of uncertainty that can be associated with the collection, interpretation and reporting of environmental data. Bioassessments are used for determining ecological integrity in wadeable streams and rivers.

Precision and bias are estimates of the total errors or uncertainty associated with an individual or set of measurements. Precision can be estimated by the repeated measurements of samples/data. Bias can be determined by repeated measurement of a known composition and/or method. In order to increase precision and decrease bias, errors are minimized by utilizing consistent methods as outlined in the Bioassessment SOP.

The following MQOs are primarily applied for QA/QC assessment and review purposes:

- Precision: Studies of variability of biological indices within reference sites across replicates conducted. The target value is within 10 points of biological index scores. Duplicate samples from QA/QC sites are the source for this data.

- Accuracy: Laboratory SOPs will be followed such that a target of 90% sorting efficiency and 90% taxonomic accuracy is achieved for BMI and periphyton samples analyzed by the selected taxonomy laboratory. Secondary QA/QC of taxonomic identification is conducted by a secondary laboratory.
- Bias: Sampling bias is avoided with adherence to sampling protocols for wadeable streams for every site visit. The consistent use of standard equipment during each sampling event also reduces bias. Sampling protocols are detailed in the SOP.
- Completeness: There are two goals for completeness. One, it is expected that 95% of all sites selected during the development of the ABP are bioassessed. Two, it is expected that 95% completeness for all sites is achieved, with 95% completeness for each component in the ABP. A loss of 5% of sites would represent a minimal loss and not affect the quality of the data gathered.

Table 9 outlines the variables/measurements MQO of the Program indicators, the level of criticalness for each variable/measurement to ensure quality data, a brief summary of collection/methods, and, where applicable, the level of precision, accuracy and completeness that should be attained.

Table 2: MQO of Bioassessment indicators.

Variable or Measurement	Class*	Range or Units	Summary of Method	Precision	Accuracy	Completeness
BMI Indicator						
Sample Collection	C	N/A	D-frame dipnet of 500 µm mesh used to collect BMI composited from 11 transects.			
Sorting and Enumeration+	C	0—600 organisms	Random, systematic selection of grids from a Caton Tray up to 600 organisms or 100% of sample.	95%	90%	99%
Identification+	C	Genus or species	Taxonomic certification of staff, specified keys and references.	85%	90%	99%
Periphyton Indicator						
Sample Collection	C	N/A	SOP procedures composited from 11 transects.			
Sorting and Enumeration+	C	0—600	Standard, accepted taxonomic practices for preparation of soft-bodied and diatom samples. (300 each soft-bodied algae & diatoms or 100% of sample.)	95%	90%	99%
Identification+	C	Genus or species	Taxonomic certification of staff, specified keys and references.	85%	90%	99%
Physical Habitat Indicator				±10%	N/A	90%
Channel and Riparian Cross-Sections at each Transect						
Wetted width	C	0.1 m	Measure wetted width with a stadia rod or tape measure.			
Wetted depth	C	0.1 m	Measure depth at 5 points on cross-section (left, center left, center, center right and right) at each transect with a meter stick.			
Substrate size	C	mm	Estimate size of substrate and assign to selected particle size using defined class descriptions at 5 points on cross-section transect.			
Bankfull width	N	0.1 m	Measure width at bankfull height with a meter stick and stadia rod or tape measure.			
Bankfull height	N	0.1 m	Measure height from water surface to estimated water surface during bankfull flow with a meter stick or tape measure.			
Bank angle	N	Degrees	Use clinometer and stadia rod to measure angle.			
Bank undercut	N	0.1 m	Measure horizontal distance of undercut.			
Bank incision	N	0.1 m	Visually estimate height from water surface to first terrace of floodplain.			
Canopy cover	C	Points of intersection	Count points of intersection on densiometer at specific points and directions on cross-section transect.			
Riparian vegetation structure	C	Percent	Observations of ground cover, understory and canopy types and coverage of an area 5 m wide and 10 m back on both banks for the cross-section transect.			
Fish cover, algae & macrophytes	C	Percent	Visually estimate in-channel features 5 m on both sides of the cross-section transect.			
Human influence	C	None	Estimate presence/absence and distance if applicable of defined types of human influenced features.			
Inter-Transect Profile						
Wetted width	C	0.1 m	Measure wetted width with a stadia rod or tape measure at inter-transect cross-section.			
Substrate size	C	mm	Estimate size of substrate and assign to selected particle size using defined class descriptions at 5 points on cross-section transect.			
Thalweg depth	N	0.1 m	Measure thalweg depth at evenly spaced intervals between transects.			
Channel	I	None	Visually estimate channel morphology using defined descriptions.			
Slope & Bearing	C	% slope ° for bearing	Backsight between cross-sections stations using clinometer, compass and stadia rod.			

*Class: C=Critical; I=Intermediate; N=Non-critical.

+Individual contracted taxonomic laboratories conduct internal QA/QC procedures and are subjected to QA/QC by a secondary contracted laboratory.

2.4 Assessments and Responsive Measures

The following QA assessments will be periodically conducted by the BWQP Supervisor, WQSAM, for the Program as described below and staff will participate in the various QA assessments. **Where the Supervisor, WQSAM is referenced in regards to QA assessments, it is understood that a designated representative may be assigned by the Supervisor to act on his or her behalf to conduct assessment and make recommendations.**

2.4.1 Data Quality Assessment

Data Quality Assessments (DQA) involves data validation activities which use the Validation, Verification and Data review reports in this document. The use of these reports standardizes the data validation process.

An in-depth DQA review and data validation for the laboratory analytical results performed by the Supervisor can be triggered two ways: one, at the request of Coordinator, the raw data would be requested from the laboratory as part of the analytical results being submitted to the Supervisor; and/or two, the Supervisor may randomly select analytical results that the Program has already received. The goal is to review and validate 10% of the analytical results that are submitted to the Program.

Problems identified through a DQA may trigger the need for a Technical System Audit (TSA) to identify technical problems or a management system review to determine management deficiencies. Any documentation resulting from a DQA will be maintained in the Program files.

2.4.2 Data Quality Reviews

The Data Quality Review (DQR) process is an assessment tool used to evaluate the documentation of the data generated for a given project. This assessment primarily involves the Supervisor evaluating the completeness of the documentation of field and analytical procedures and the QC results. It usually involves tracking stream survey forms and on-site paperwork from sample collection and custody to analytical results and entry into a database. This technique is commonly used to verify the process involved in entering data into large regulatory databases.

The results of a DQR can be used by Program staff in two ways: first, it can be used in making recommendations for changes in the design and performance of data collection efforts and in the use and documentation of QC procedures; and secondly, the results can be used as a guide for the planning and acquisition of supplemental data for the project area as well as for other potentially related projects.

Problems identified through the DQR process may trigger the need for a TSA to identify technical problems or a management system review to determine management deficiencies. Any documentation resulting from a DQR will be maintained in the Program files.

2.4.3 Field Audits

Annual field audits are conducted to critically review and appraise field sampling activities. Field audits can consist of either:

- An on-site visit to the sampling location and observation of sampling practices; or
- Repeat physical habitat and *in-situ* water chemistry measurements collected on the same date at a sample location.

The first field audit option is an on-site visit conducted by the Supervisor who during the audit "shadows" the field crew, making and recording observations. At the conclusion of the field audit, the Supervisor will review with the field crew areas needed for improvement. Attachment B, Nevada Field Audit Form, will be completed.

To perform the second field audit option, two field crews will bioassess the same stream with one crew starting at the lowest transect in the reach (A) and the second starting at the mid-reach transect (F) for a total of eleven transects per field audit. Both crews will bioassess the entire stream reach for physical habitat indicators and *in-situ* water chemistry. At the conclusion of the event, completed field data forms will be compared side-by-side for each transect to determine deviations between physical habitat values. Values that are objective, i.e., measurements that can be quantified, will be compared for accuracy. Values that are subjective, i.e., riparian visual estimates of human influences, will be compared, discussed and verified by the Coordinator and/or Supervisor. At the conclusion of the field audit, the Supervisor will review with the field crew areas needed for improvement.

In both scenarios, the Supervisor records any deviations from the SOPs and findings are documented. Follow-up discussion of methods or training is provided to remedy any problems. The primary intention of such audits is to ascertain whether the SOP procedures are being followed. If deviations from the SOP are critical, additional training will be provided. If a single crew member is consistently deviating from the Bioassessment SOP, corrective actions will be enforced. Corrective actions include additional training where necessary, individual performance evaluation by the Coordinator or Supervisor up to termination of seasonal employment if determined that corrective actions are not sufficient, or if the crew member is intentionally negligent in his or her assignments and responsibilities.

Field sampling audit activities can be performed by the Supervisor or a contractor. When a contractor is used, the external audit will be under the supervision of the Supervisor. Requests for external audits go through the Supervisor. All field auditing activities will result in the production of a written report. A draft of the report from the auditor is due within seven (7) calendar days of the completion of the observational phase of the audit. The draft will be sent for comments to the Coordinator. Written comments by the Coordinator and/or the sampler will be supplied to the Supervisor. Final reports generated by the Supervisor are to be completed within 30 calendar days of receipt of the comments. Copies of the final report, with recommendations for corrective measures, will be stored in the Program files. Additional copies will be distributed as appropriate.

Corrective measures will be taken by the Program as necessary to assure that the environmental measurements will be of a known quality and will be sufficient for their intended purpose. The corrective measures will be adopted by staff within the Program so that future field sampling will be corrected for the project area in question.

2.4.4 Technical System Audits

Technical System Audits will be conducted periodically to assess the sampling and analytical quality control procedures used to generate environmental data. The Supervisor or Coordinator may request a TSA. The TSA will consist of evaluation of various components of the sampling program, outlined below in Table 10.

The TSA will be conducted by the Supervisor. Results of the audit will be prepared and submitted to the Program staff in the form of a written report. Written responses prepared by the Coordinator will be supplied to Supervisor. Copies of the TSA final report, with recommendations for corrective measures, will be stored in the ABP file. Corrective measures will be taken by the Program as necessary to assure that the environmental measurements will be of a known quality and will be sufficient to meet MQOs.

Table 3: Technical System Audit report required elements
• Is staff training in bioassessment methods up to date?
• Are water testing instruments properly maintained and calibrated?
• Has bioassessment equipment been properly maintained and cleaned?
• Are proper field procedures followed according to protocols?
• Field audit yielded acceptable results?
• Laboratory audit yielded acceptable results?
• Supervisor signature and date

2.4.5 Reports

Effective communications between all Program personnel is an integral part of the quality system. Planned reports provide a structure for apprising management of the Program's ABP, deviations from planned activities, the impact of the deviations, and the uncertainties in decisions based on the data. This section of the QAPrP identifies the requirements for the QA reports to management.

2.4.5.1 Data Quality Assessment

Data Quality Assessments, as referred to in 5.4.1, will be conducted by the Supervisor. Results of DQA reports will be given to the Coordinator and recommendations for improvements will be discussed.

2.4.5.2 Data Quality Review

Data Quality Reviews, as referred to in 5.4.2, will be performed by the Supervisor. The goal is to review and validate 10% of the submitted results. Results of DQR reports will be given to the Coordinator and recommendations for improvements will be discussed.

2.4.5.3 Field Audits

Annual field audits, as referred to in 5.4.3, will be requested and performed by the Supervisor at his or her discretion. The goal is to review and validate the submitted results. Results will be given to the Coordinator. Recommendations for improvements will be forwarded to the Bureau Chief or designated representative.

2.4.5.4 Corrective Measures

Corrective measures can be the result of situations involving field activities or laboratory activities. DQAs and DQRs can also indicate a need for corrective measures. Corrective measures will be taken as necessary to assure that the environmental measurements will be of a known quality and will be sufficient to meet the Program MQOs. Corrective measures will be adopted as appropriate.

Field corrective measures generally are the responsibility of the crew as directed by the Coordinator. Some corrective measures can be taken in the field. Problems can result from situations such as malfunctioning or broken field equipment, inability to access a sampling site or an inability to deliver samples into the analytical laboratory prior to holding time being exceeded. Regardless of the source of the problem or whether or not it can be corrected, it will be documented in the appropriate field forms. Corrective measures can include such items as performing additional decontamination of equipment, re-sampling, locating alternative sites or obtaining additional training of field personnel. Each corrective action will be documented with a description of the deficiency and the corrective action taken, and the person responsible for implementing the corrective action.

Any corrective action requiring re-sampling will be considered a minor corrective action. All corrective action that requires a change to the existing QA project plan or SOP will be considered a major corrective action. A major corrective action will require modifications to the ABP, which would require a review and approval for the modifications. All documentation resulting from a corrective action will be maintained in the project files.

2.5 Data Validation and Verification, Validation, and Data Review

Data validation activities ensure that laboratory data are accurate. Data verification involves verifying that overall sampling, laboratory analysis and database generation activities were conducted appropriately and as per the Bioassessment Standard Operating Procedure (SOP). Data review is conducted to ensure that data has been screened prior to entry into the EDAS database and data is of sufficient quality for designated analysis determinations.

2.5.1 Verification

Verification of data involves determinations that overall sample collection, laboratory analysis, and data entry procedures have been correctly followed and data and measurement quality objectives have been met. Verification activities involve determinations that the Bioassessment SOPs for collecting biological samples were correctly followed, that Chain of Custody (COC) procedures were followed, that laboratory data has been validated, and that general MQOs have been met. The Supervisor will conduct a data verification review for each annual dataset collected, to be documented in the Verification Report (refer to Table 11). A copy of the Verification report will be filed in the Program files. An example COC form is shown in Figure 4.

Table 4: Biological data verification report required elements

Verification Report for Data Package (name and date)
SOPs • Were Bioassessment SOPs followed during collection of biological samples? This includes correct habitat, index period, general sampling conditions and correct preservation of samples. • COC followed by the Program and documentation provided by laboratory?
Laboratory Result Validation • Were laboratory results produced for each sample submitted to the taxonomic laboratory? Was a Laboratory Validation report produced and laboratory data validated for Bioassessment Program use? • General MQOs met • MQOs have been met • Recommendations for improvement if needed
A summary of all communications regarding QC problems or qualifications in the dataset is provided
Supervisor signature and date

2.5.2 Validation

The validation process involves review of laboratory taxonomic data to ensure that data meets MQOs, prior to incorporation into the EDAS database. The Coordinator will conduct data validation activities, which will be documented in the Data Validation Report (refer to Table 12). The contracted taxonomic laboratory with the Program conducts most of the following QC checks and the Program provides a review of these activities to validate the data package. A copy of the Validation Report will be included in the Bioassessment Program Laboratory Data Files.

- COC procedures were followed;
- Sorting efficiency check is attained;
- A minimum of 600 BMI are identified for each BMI sample, or 100% of the sample;
- A minimum of 300 soft-bodied algae and 300 diatoms are identified for each periphyton sample, or 100% of the sample;
- Accuracy of taxonomic identifications is >90% with checks done by a secondary laboratory taxonomist on 10% of the annual batch of samples for BMI and digital photograph reference collection for periphyton; and
- Data entry of results from bench sheets to database files is correct.

Table 5: Laboratory Data Validation report required elements
Validation Report for Taxonomy Data Package (name and date)
Laboratory QC
Have any QC problems been identified in the laboratory QC reports? What corrective action, if any, was taken?
COC documentation
• Have original COC forms with ID numbers and laboratory receipt signatures been submitted?
Electronic laboratory data
• Laboratory taxonomic data results have been provided for each biological sample submitted. The results are supplied electronically in database format, as specified by the Bioassessment Coordinator. Data has been entered correctly (10% check) from bench sheets to database files.
QC Summary: Is the following information included?
• Duplicate samples have similar taxa list and biological indices scores;
• Record of Caton Tray proportion of sample analyzed (BMI);
• Minimum of 600 count per sample is recorded (BMI)*;
• Minimum of 300 soft-bodied algae and 300 diatom per sample is recorded (periphyton)*;
• List of new taxa and attributes is provided;
• Sorting efficiency check has been met; and
• Results been submitted within twelve months of sample delivery.
Summary of laboratory communications or qualification on the dataset
Supervisor signature and date
*or 100% completion of sample in the event a 600 count is unattainable.

2.5.3 Data Review

Data review is conducted to ensure that data has been screened prior to entry into the EDAS database and data is of sufficient quality for the Program’s objectivies.

The field and laboratory data upload process is reviewed by the Supervisor to ensure that database QC procedures have been followed. Determinations that the data is acceptable for scientific analyses, calculation of indices, biological assessments and other purposes are made as part of the data review by the Supervisor, Standards and Monitoring. The review will include the items described in the table below. Data review will be conducted on each annual data package and will be documented in the Data Review Report shown below (refer to Table 13). A copy of this report will be included in the Program Data files.

Table 6: Data Review Report required elements
Data Review for Taxonomy Data Package (name and date)
Laboratory Data Validated (yes or no; if no provide comments on follow up actions)
Data Package Verified and MQO met (yes or no; if no provide comments regarding follow up actions)
Data Outliers • Data was reviewed for outlier values. Any outlier values are checked with the taxonomy laboratory and corrective measures taken.
Data uploads to EDAS • Electronic dataset has been successfully uploaded into the Programs EDAS and QC on the data upload completed.
Data is acceptable for data analysis and decision making
Supervisor signature and date

2.5.4 Taxonomic QA/QC by a Secondary Laboratory

2.5.4.1 Benthic Macroinvertebrates

A secondary taxonomic laboratory receives from the Program approximately 10% total site vouchers per year of previous enumerated and identified BMI samples by a separate taxonomic laboratory. The laboratory's responsibility will be to QA/QC for the re-identification and enumeration of the samples randomly selected by the Coordinator. Identification levels will be, at the minimum, the taxonomic effort provided in the Southwest Association of Freshwater Invertebrate Taxonomists Level II or similar level of taxonomic resolution.

Upon completion of the QA/QC identification and enumeration, the laboratory will request from the Program the original BMI laboratory results. The QA/QC laboratory provides the Program with an electronic spreadsheet consisting of a side by side comparison of the primary macroinvertebrate laboratory results and the QA/QC laboratory results.

It will be the responsibility of the QA/QC laboratory to contact the primary BMI laboratory when discrepancies are found. Both laboratories are to reconcile the differences as much as feasible. The QA/QC laboratory will provide a brief factual electronic report discussing the discrepancies, QA/QC recommendations, and if the laboratories reach a reconciliation regarding the discrepancies. If reconciliation cannot be reached, an independent third-party may be required for identification. Based on any discrepancies found, the Program will update the taxonomic results as appropriate. Communications regarding reconciliation between the two taxonomic laboratories are stored electronically on the NDEP server along with that index period's taxonomic results. Results of the QA/QC are required within six months of receipt from the primary taxonomic laboratory.

2.5.4.2 Periphyton

The secondary QA/QC laboratory will receive from the Program the digital photograph reference collection from the previous enumerated and identified samples by a separate laboratory. The laboratory's responsibility will be to perform QA/QC for the identification of the reference collection. The QA/QC laboratory provides the Program with an electronic spreadsheet of identification results. The Program will compare the taxonomic results from each laboratory's identification with percent of species composition similarity, which should not be ≥70% between the two independent taxonomic laboratory identifications.

Upon completion of the QA/QC identification, the laboratory requests the original periphyton laboratory results and percent of similarity results. It will be the responsibility of the QA/QC laboratory to contact the primary periphyton laboratory when discrepancies are found. Both laboratories are to reconcile the differences as much as feasible. The QA/QC laboratory will provide a brief factual electronic report discussing the discrepancies, QA/QC recommendations, and if the laboratories reached a reconciliation regarding the discrepancies. If reconciliation cannot be reached, an independent third-party may be required for identification. Based on any discrepancies found, the Program will update the taxonomic results as appropriate. Communications regarding reconciliation between the two taxonomic laboratories are stored electronically on the NDEP server along with that index period's taxonomic results. Results of the QA/QC are required within six months of receipt from the primary taxonomic laboratory.

2.5.5 Reconciliation with MQO

Determinations that MQO have been met are documented in the Laboratory Data Validation and Verification reports. Any QC problems, data qualifications or laboratory communications are documented in the Validation, Verification, or Data Review Reports. Reconciliation actions with respect to MQO are discussed in the Data Review Report. When the Data Review Report is completed, data are approved for data analysis and decision making purposes, which might include calculation of biological indices, biological assessments and other statistical analyses.

3 APPENDIX A: STANDARD OPERATING PROCEDURE

This Standard Operating Procedure (SOP) will be used for bioassessments at wadeable stream and river sites. This section presents a general overview of the activities that a field crew conduct during a typical sampling visit to a site. General guidelines for recording data using standardized Stream Survey Forms and sample labels are also presented. Finally, safety and health considerations and guidelines related to field operations are described.

3.1 Pre-Sampling Site Verification

The standard index period of field sampling is mid-May through mid-September unless circumstances arise that require the need for a bioassessment outside of the field season. Each year, an ABP is developed outlining the Program's objectives, what methods will be employed to attain those objectives, and a selection of sites in support of stated objectives. Sites are reference, probabilistic, targeted (including impaired) and repeat (including reference, probabilistic and targeted).

Sites are evaluated via desktop (GIS maps, satellite imagery, BWQP knowledge and local inquiries). Access is determined for primary and alternative sites. Alternative sites are clustered around the primary site for ease of access while maintaining sampling integrity. Where necessary and feasible, access permission is obtained. Sites may require in-field site confirmation to determine suitability of sampling during the index period. Sites that fall outside of Nevada state borders are not sampled unless a representative of that particular state (e.g. California) who holds a scientific collection permit is present during the bioassessment.

For each site, a dossier is prepared and contains the following applicable information: road maps, copies of written access permissions (where applicable), scientific collection permits, Global Positioning System (GPS) (NAD83) coordinates of sites, and a topographic map with the site location marked. As the Program requires repeat visits to select sampling sites, it is important for the field crews to do everything possible to maintain good relationships with landowners. This includes prior contact, respect of special requests, closing gates, minimal site disturbance and removal of all materials including flagging and trash.

3.2 Base Activities

Travel arrangements with lodging, maps and directions, shipping locations and times if necessary, and other field amenities are planned prior to a bioassessment. The appropriate NDEP travel request forms are processed. During the field season, vehicle inspections are conducted at the beginning and end of each week. Vehicle inspections include checking the integrity of the tires, tire pressure, fluid levels and minor damage (if any).

Prior to use, all field equipment must be calibrated to manufacturers' recommendations and accepted laboratory protocol where applicable. Sample bottles, filtering apparatus and collection equipment are inspected prior to use for chips, cracks, leaks, contamination and other deformities that may affect the outcome of the sampling effort. The Coordinator is responsible for the maintenance and calibration of all equipment and must report, record, repair and/or replace as necessary probes and equipment.

Sampling equipment is prepared on a weekly basis. The Bioassessment Field Equipment Check List (Table 2) details the equipment required for a typical bioassessment. Calibration of multiparameter sondes is conducted for pH and conductivity. The DO membrane is inspected for integrity, replaced if necessary and changed at least monthly during use. Dissolved oxygen is calibrated at the X-site to account for altitude/barometric pressure. Quarterly, a temperature comparison between sondes is conducted and compared to a NIST thermometer. Annually, the sondes are sent to the manufacturer or other authorized maintenance provider for service and calibration. All other bioassessment equipment is inspected for wear and replaced as necessary.

Calibration information is recorded on the Stream Survey Form, Section Field Measurement (Attachment A).

Table 7: Bioassessment Field Equipment Check List

Sampling Indicator	Equipment/Supplies
General	☐ Clipboards ☐ Pencils ☐ Permanent markers ☐ Scissors ☐ Packing tape ☐ Duct tape ☐ Electrical tape ☐ First aid kit ☐ Batteries
Stream Verification	☐ Stream Survey Forms ☐ GPS Unit(s) set to NAD83 and metric units ☐ Topographic maps ☐ Nevada Department of Transportation Map Atlas and/or additional recreational map atlases ☐ Map directions ☐ Access permission (where applicable)
Water Quality/ Chemistry	☐ Chain-of-custody (COC) forms ☐ Multi-parameter sonde (YSI) ☐ Calibration solutions for pH and conductivity ☐ DO membranes and DO probe electrolyte solution ☐ Nitrile gloves ☐ 1.9 L General Parameter bottles (x2) - blue cap (unpreserved) and red cap (preserved) ☐ Sulfuric acid (H_2SO_4) preservative ampules ☐ 500 mL Metals bottles with preservative (x2) - one for total recoverable and one for dissolved ☐ Filters for dissolved metals ☐ Vacuum hand pump ☐ Transfer bottle for holding water to be pumped for dissolved metals ☐ Beaker ☐ 120 mL Bacteria bottle (x1) ☐ Ampule waste bottle ☐ Wet ice

(Bioassessment Field Equipment Check List, continued.)	
PHab Channel Cross-Section	☐ Tape measure (m) ☐ Stadia rod (m) ☐ Measuring rod (cm) ☐ Clinometer ☐ Densiometer ☐ Landscape flags or tape ☐ Laser range finder
Benthic Macroinvertebrate	☐ D-frame dipnet (500 μm mesh) ☐ Forceps ☐ Ethanol (90%) ☐ Wide-mouth HDPE jar(s) ☐ Metal scoop ☐ Interior and exterior labels
Periphyton/ Chlorophyll-*a*	☐ Circular delineator (2.5 cm diameter) ☐ Small brush ☐ Syringe with tip removed (60 mL) ☐ Wash bottle for stream water rinse ☐ Funnel ☐ 500 mL Nalgene bottle (x1) delineated for 45 mL collection per transect ☐ Small cooler with wet ice to store sample collection bottle between transects ☐ Graduated cylinder (500 mL) ☐ Deionized (DI) water wash bottle ☐ Centrifuge tube (50 mL) ☐ Labels ☐ Formalin ☐ 2 mL disposable pipette ☐ Whatman 47 mm 0.7 micron GF/F glass fiber filters ☐ Filtration unit ☐ Vacuum pump (hand or electric) ☐ Aluminum foil
Slope and Bearing	☐ Stadia rod (m) ☐ Measuring rod (cm) ☐ Tape measure (m) ☐ Clinometer ☐ Compass ☐ Surveyor's level ☐ Tripod
Stream Discharge	☐ Velocity Area ○ Current velocity meter with top-set wading rod and propellers ○ Tape measure (m) ○ Measuring rod (cm) ☐ Neutral Buoyant Object ○ Small whiffle/ping-pong ball ○ Tape measure (m) ○ Measuring rod (cm) ○ Stopwatch
Decontamination	☐ Personal protective equipment (nitrile gloves, eye protection) ☐ Hand pump sprayer with 10% bleach solution ☐ Hand pump sprayer with tap water ☐ Spray bottle with 100% white vinegar ☐ Spray bottle with 10% bleach solution ☐ Scrub brushes

3.3 Site Activities

Field methods are designed to be completed in one site visit. Depending on the time needed for both the sampling and travel for the day, an additional day may be needed to complete sampling or for pre-departure and post-sampling activities (e.g., cleaning and repairing equipment, shipping samples, and traveling to the next site). Remote sites with lengthy or difficult approaches may require more time.

Due to the remoteness of many of the State's streams and rivers, a variety of methods may be used to access a site, including 4WD and off-road all-terrain vehicles. Some sites may require teams to hike in transporting equipment in backpacks. Crews may be required to camp near the site and will be required to provide his or her own personal camping equipment and food. The crews will use standard field equipment and supplies which are provided by the Program.

Each field crew should define roles and responsibilities for each crew member at the onset of each sampling day. A field crew will typically consist of two people. In the absence of a field lead, the Coordinator will select a daily lead for the crew who is responsible for ensuring the completion of stream survey forms, decontamination of equipment, and review the day's activity to address any issues that may have arisen.

The Stream Survey Form is Attachment A to this document. All of sampling activities will be recorded utilizing these forms and are later entered into the main EDAS database. Additional forms include water chemistry forms including COC, back-up forms, and field notebooks to document any occurrences outside of the bioassessment activities. Prior to departure from the site, a crew member other than the person who recorded the original data reviews all forms for completeness and ensures reconciliation of sample jar labels with site information (site identification, date, preservative, sample type).

The field crew arrives at the site to complete the sampling. The sampling sequence is to:

- verify site and locate X-site
- conduct *in-situ* measurements of DO, pH, conductivity, and water temperature
- collect and preserve water chemistry samples
- conduct physical habitat characterization
- conduct channel cross-section profile
- collect BMI samples
- collect periphyton samples (and chlorophyll-*a* if applicable)
- conduct inter-transect or thalweg measurements
- measure slope and bearing
- measure stream discharge
- filter chlorophyll-*a* samples (if applicable)
- preserve and prepare BMI and periphyton samples
- decontaminate equipment
- review stream survey forms and other field forms

3.3.1 Verify Site and Locate the X-Site

Utilizing a GPS unit set to NAD83 with metric units, the coordinates are entered prior to traveling to the site. Topographic maps, an aerial image, and driving directions are provided for each site. The decimal degree latitude and longitude coordinates represent the X-site. Sites selected by the EPA and/or other outside sources for probabilistic and/or reference sites generally have the X-site mid-reach (F transect). If the site is a repeat visit, the X-site is mid-reach. The only occasions with the X-site is at the beginning of the reach is when the site is identified as an impaired site by BWQP for water quality, and the coordinates will represent the A-transect thereby allowing a full bioassessment of the reach including and upstream of the location where water quality samples have been routinely obtained. Record the actual GPS value at the X-site as displayed by the GPS unit.

After the field crew confirms and arrives at the X-site, a stream evaluation is conducted to determine whether or not the stream is sampleable or non-sampleable. Sampling status confirmation is provided in Table 3. The primary difference between statuses is the presence of water in a defined channel at a site that is accessible.

Table 8: Sample Status

Sampleable	Non-Sampleable
☐ Wadeable – continuous water, >50% wadeable	Permanent
	☐ Dry, visited
☐ Partial wadeable – explain	☐ Dry, not visited
	☐ Wetland
☐ Wadeable interrupted – not continuous water along reach	☐ Map Error – no waterbody present
	☐ Impounded – under a reservoir, lake, or pond
☐ Altered – stream/river present but not as on map	Temporary
	☐ Other – explain
	☐ Not wadeable
	No Access
	☐ Access permission denied
	☐ Permanently inaccessible – unable/unsafe to reach site
	☐ Temporally inaccessible – fire, etc.

Crew members should walk along the reach to confirm presence of water. If the site is dry, refer to Section 4.3.4. Do not walk in the stream channel during this evaluation in order to preserve the integrity and undisturbed nature of the stream. When water is not present at the X-site, but within the reach, the field crew may slide the X-site within the predetermined reach to develop a new reach with new GPS coordinates for the X-site; however, the crew may not slide the X-site entirely out of the original reach to obtain a reach that has a greater amount of flowing water. If the site is determined not to be sampleable, one of the Non-Sampleable categories need to be selected as outlined in Table 3.

Once the site has been determined sampleable and the X-site is confirmed, the reach should be laid out. The wetted width at the X-site determines the reach length of which 50% will be downstream of the X-site and 50% will be upstream of the X-site. Reach length should be 40 times (40×) the wetted width or a minimum of 150 meters. Therefore, a wetted width of 2.5 m multiplied by 40 would only be 100 m. In this example, the sampling reach would be lengthened to 150 m. If the stream width was 6.25 m multiplied by 40, then the sampling reach would be 250 m. From the reach length, the eleven equally spaced transects (A-K) will be determined, in addition to equally spaced thalweg depth stations between each transect OR inter-transects which would be one-half the distance between each transect.

Site information is recorded on the Stream Survey Form, Section Stream Verification (Attachment A).

3.3.2 *In-situ* Chemistry Measurements

The multi-parameter sonde should be powered upon arrival at the site to allow time for the probes to stabilize. Once crew members have confirmed the X-site, calibrate the sonde for altitude/barometric pressure. Place the probe in mid-channel at the X-site and allow to stabilize for at least 5 minutes prior to reconding measurements of DO, pH, water temperature, and conductivity. Additionally, time of day should be recorded. Measurements and units are outlined in Table 4.

In-situ information is recorded on the Stream Survey Form, Section Field Measurement (Attachment A).

Table 9: *In-situ* Measurements

Measurement	Unit
Time	Military
Water Temperature	°C
Dissolved Oxygen (DO)	mg/L
Percent Dissolved Oxygen Saturation	%
pH	--
Conductivity	μS/cm @ 25°C
Ambient Air Temperature	°C or °F

3.3.3 Water Chemistry

At the X-site, water chemistry samples should be taken and placed on wet ice until delivery to the designated Nevada certified analytical laboratory. Crew members are responsible for completing the appropriate COC forms at the time of sampling. Ultimately, the BWQP Standards and Monitoring protocol (NDEP 2014) should be followed when obtaining these samples; however, the following is a brief outline for the collection procedure.

- Crew members label all bottles in two locations where possible with a permanent marker with the site ID and whether or not a preservative was added. Additionally, label the lids, tops or shoulder of the bottles where possible.
- It is mandatory for the crew member doing the collection to glove-up with nitrile gloves prior to any rinsing or collection.
- All sampling equipment (beaker, dipper, churn splitter, transfer bottle) and non-preserved (general parameters) bottles and caps need to be rinsed three (3) times prior to filling with sample water. **DO NOT rinse the metal and bacteria bottles.** These bottles have been prepared with preservative and do not require rinsing. Metals bottles contain nitric acid (HNO_3) preservative and the bacteria bottle is preserved with sodium thiosulfate ($Na_2S_2O_3$).
- From either the churn splitter or the beaker, the crew member fills the bacteria and total recoverable metals sample bottles. Fill the total recoverable metals bottle to the shoulder of the bottle, i.e., almost to the top but not completely full. Fill the bacteria bottle to the line indicated on bottle (which is 100 mL). If the bacteria sample is being held on wet ice, double bag the sample with plastic ziplock bags. Fill the transfer bottle for filtering for dissolved metals.
- The crew member fills both of the general parameter bottles. The blue capped bottle is not preserved. The red capped bottle is preserved with one ampule of sulfuric (H_2SO_4) acid prior to final capping. The red capped bottle needs to have “preserved” noted. Fill the bottles to the shoulder of the bottle, i.e., almost to the top but not completely full.
- Using the transfer bottle, the crew member connects the transfer bottle’s lid’s attached plastic tubing to the dissolved metals filter. Imagine the filter as a hat, with the curved topped attached to the transfer bottle tubing and the opening on the flat bottle which will go directly into the dissolved metals sample bottle. The vacuum hand pump will be attached to the transfer bottle lid. Hold the transfer bottle upside down with the filter placed directly over dissolved metals sample bottle and begin to pump water through the filter. Continue pumping until water comes up the shoulder of the bottle, i.e., almost to the top but not completely full.
- Once the water chemistry samples have been collected, place all samples on wet ice until delivery to the analytical laboratory. Where necessary, double plastic ziplock bag bacteria samples to avoid contamination with melted ice water. Refresh the ice as necessary.

Water routine chemistry information is recorded on the Stream Survey Form, Sections Field Measurement and Sample Collection (Attachment A).

3.3.4 Dry Site Alternatives

Generally, the ABP and weekly sampling schedule includes alternative sites within reasonable distance from the primary assigned site in the event the primary site is unsampleable. Many reasons may preclude a primary assigned site from being bioassessed including lack of water, private property, and temporarily unsafe conditions (i.e., presence of livestock, construction, water treatments, etc.). In the event that the primary assigned site is accessible but dry, and an alternative site is not scheduled, the crew should perform a modified bioassessment to include all elements of a bioassessment with the exception of BMI and periphyton collection, discharge measurements and other measurements dependent upon the presence of flowing water.

3.4 Physical Habitat Characterization

Once the reach length has been determined and laid out, measurements of physical habitat (PHab), cross-sectional substrate, riparian coverage, fish coverage, canopy, thalweg, and slope/bearing are obtained from eleven transects (A – K). To preserve the undisturbed status of each transect, crew members should start at the A-transect and work upstream to the final transect, K. All physical measurements begin on the left bank. Crews determine the left bank by facing in the downstream direction. The left bank is on the left of the crew member while facing downstream.

Physical habitat characterization information is recorded on the Stream Survey Form, Section PHab Channel/Riparian Cross-Section (Attachment A).

3.4.1 Bank Measurements

At each transect, the first step is to measure the wetted width. Using a stadia rod or tape measure, crew members measure the wetted width in meters (m). Wetted width is the distance bank to bank where the water meets the bank. If there is a bar* within the stream channel, the wetted width would include the bar; however, the bar width (m) needs to be measured, too. Boulder outcroppings and large diameter logs are not considered bars.

- * Bars are considered to be below the bankfull height measurements, whereas an island's terrain would be equal to or above bankfull height. Occasionally due to low flows, what would not normally be considered a bar in normal flow years may be exposed. Best professional judgment in the field determines whether or not this feature would be considered a bar. Should either a bar or an island have a flow that would be equal to or greater than 50% of the main channel, a side channel PHab form is to be completed.

Bankfull width (m) is measured where the water level would be if the streamflow was at maximum but not flood stage. Bankfull width is determined by using visual clues such as water or scour marks, bank terraces and bank vegetation that provide evidence to the bankfull level. Once the bankfull width has been determined, bankfull height (m) is measured by vertically placing the bottom end of the measuring rod at the waters' surface, aligning and measuring the height to the stadia rod or tape measure spanning the bankfull width.

The vertical distance (height) from the observed water surface up to the level of the first major valley depositional surface is a measure of incision of the stream below the general level of its valley. Generally in Nevada, incised height (m) is where the stream has cut into the channel over time leaving a near vertical incision on one or both banks. The incision may be directly adjacent to the bank or further back from the stream channel and may be obscured by vegetation. A visual estimate for incised height is acceptable. Incised height is always equal to or greater than bankfull height – never less than bankfull height.

Bank angles (°) are measured on the left and right bank and include undercut distance where applicable. Crew members may estimate angles especially when near vertical without undercutting. For a more precise bank angle, lay the measuring rod down against the bank with one end at the water's edge. At least 0.5 m of the measuring rod should be resting comfortably on the ground to determine bank angle. Lay the clinometer on the rod, and read the bank angle in degrees from the external scale on the clinometer (viewing window on side of clinometer rather than through the eye piece). A vertical bank is 90°, overhanging banks have angles >90° approaching 180° and more gradually sloped banks have angles <90°. To measure bank angles >90°, turn the clinometer (which only reads 0 to 90°) over and subtract the angle reading from 180°. If there is a large boulder or log present is at the transect, measure bank angle at a nearby point where conditions are more representative.

If the bank is undercut, the crew members need to measure the horizontal distance of the undercutting to the nearest 0.01 m. The undercut distance is the distance from the water's edge out to the point where a vertical plumb line from the bank would hit the water's surface. Measure submerged undercuts by placing the rod into the undercut and reading the length of the rod that is hidden by the undercutting.

3.4.2 Substrate Cross-Section

Crew members should divide the wetted width of the transect into 5 equal distances. These equal distances are known as left, left-center, center, right-center and right. Left bank would be 0 m, center would be half of the wetted width, and right bank would be the full wetted width. At each distance from the left bank, and including the left bank, four measurements will be obtained: (1) distance from the left bank, (2) water depth (cm) at each location, (3) substrate size classification (Table 4) and (4) percent embeddedness (Table 4). At each station (left, left-center, center, right-center, and right) the crew member will measure the water depth (cm) with a measuring rod. Without feeling around, the crew member touches the channel bottom where the depth measurement was made to determine substrate size classification and estimates the percent embeddedness (Table 5). For five substrate classifications, there is a pre-determined embeddedness. However, for the remaining size classes, embeddedness needs to be estimated as to how much of the substrate (cobble, boulder, etc.) is embedded in the channel bottom (Table 5).

Table 10: Substrate size class classification and percent embeddedness

Code	Size Class	Size Range (mm)	Description	Embeddedness (%)
RS	Bedrock (Smooth)	>4000	Smooth surface rock bigger than a car	0
RR	Bedrock (Rough)	>4000	Rough surface rock bigger than a car	0
HP	Hardpan	>4000	Firm, consolidated fine substrate	0
XB	Boulders (large)	>1000 to 4000	Yard/meter stick to car size	
SB	Boulders (small)	>250 to 1000	Basketball to yard/meter stick size	
CB	Cobbles	>64 to 250	Tennis ball to basketball size	
GC	Gravel (Coarse)	>16 to 64	Marble to tennis ball size	
GF	Gravel (Fine)	> 2 to 16	Ladybug to marble size	
SA	Sand	>0.06 to 2	Smaller than ladybug size - gritty between fingers	100
FN	Fines	≤0.06	Silt Clay Muck (not gritty between fingers)	100
WD	Wood		Wood & other organic particles	
RC	Concrete/Asphalt		Record size class in comment field	
OT	Other		Metal, tires, car bodies etc. (describe in comments)	

3.4.3 Canopy Cover

Canopy cover over the stream is determined at each transect using a convex spherical densiometer. The densiometer is marked with a V line to limit the number of square grid intersections read to 17 (Figure 2). Densiometer readings can range from 0 (no canopy cover) to 17 (maximum canopy cover). Six measurements are obtained at each transect (four measurements in each of four directions at mid-channel and one at each bank).

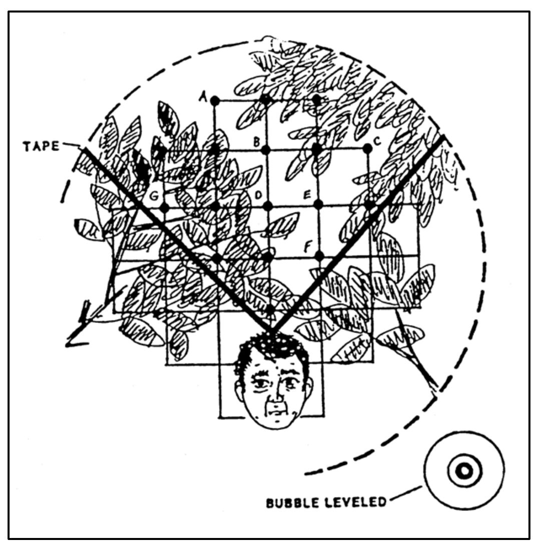

Figure 2: Densiometer with V delineation.

To measure canopy cover, the crew member holds the densiometer level at 0.3 m above the water's surface at both the center of the channel and at each bank with the crew member's face reflected just below the apex of the "V." View the 17 points of grid intersection on the densiometer that lie within the marked "V." If the reflection of any vegetation overlies an intersection point, that particular intersection is counted as having cover. Open sky is counted as not having coverage. When measuring at the center of the channel, the crew member needs to hold the densiometer in one location while rotating his or her body around the mirror to obtain the four measurements (center-up, center-left, center-down, and center-right) – the densiometer remains nearly stationary while the crew member changes position. At each bank, with the crew member facing the bank, canopy cover measurements are made.

3.4.4 Fish Coverage

The Fish Coverage category lists aquatic attributes that would increase the area that fish could use as habitat and refuge. The attributes include filamentous algae, macrophytes, woody debris, live trees and roots, vegetation such as branches overhanging the water's surface, undercut banks, and boulders. Occasionally, an artificial structure such as a dock or rip-rap may be considered fish cover. At each transect, the crew member visually observes an area 5 meters up- and downstream on both banks for the presence of fish cover. Each of these attributes is noted with coverage estimate values noted in Table 6.

3.4.5 Visual Riparian Estimate

A visual riparian assessment is conducted by a crew member at each transect looking 5 meters up- and downstream, and 10 meters back from each bank. Riparian vegetation for canopy (>5 meters high) and understory (0.5>5 meters high) are categorized as deciduous, coniferous, broadleaf evergreen, mixed, or none. In the canopy, trees are delineated between large (>0.3 meters diameter at breast height (DBH)) and small (<0.3 meters DBH). In the understory, woody shrubs and saplings are quantified separately from non-woody herbs, grasses, and forbs. Ground cover includes the two categories noted in the understory and includes duff, bare dirt, or barren. Each of these attributes is noted with coverage estimate values noted above in Table 6.

Table 11: Visual coverage estimate values for Fish Coverage and Visual Riparian Estimates

Cover	Percentage	Value
Absent	0%	0
Sparse	<10%	1
Moderate	10—40%	2
Heavy	40—75%	3
Very Heavy	>75%	4

3.4.6 Human Influence

At each transect, the crew member observes human influences on both banks. The eleven influences are outlined in Table 7. For each influence, the crew member determines if it is: Not Present (0), Present (P) which is >10 meters from the bank, Close (C) representing within 10 meters of the bank, and on the Bank (B). This assessment is conducted 5 meters up- and downstream and looking back from each bank. Influences must be within the crew member's field of view and is not sighted through a different transect unless noted attribute is in both transects.

Table 12: Human Influences

Human Influences Attributes		Attribute Measurement	Value
Walls/Dikes/Revetment/ Riprap/Dam		Not Present	0
Buildings	Park/Lawn	Present (>10 m from bank)	P
Pavement/Cleared Lot	Row Crops	Close (<10 m from bank)	C
Roads/Railroad	Pasture/Range/Hay Field	On Bank	B
Pipes (inlet/outlet)	Logging Operations		
Landfill/Trash	Mining Activity		

3.5 Collection of Benthic Macroinvertebrates and Periphyton

Biological indicators, BMI and periphyton, are collected according to a margin-center-margin scheme. A diagram is shown in Figure 3. At the initial transect (A), take the first samples approximately one meter upstream of the cross-section closest to the left bank (margin). At the B-transect, obtain the samples in the center of the stream channel and the samples are collected at the right bank at the C-transect. Repeat the margin-center-margin collection pattern throughout the remainder of the reach. Utilizing this collection method

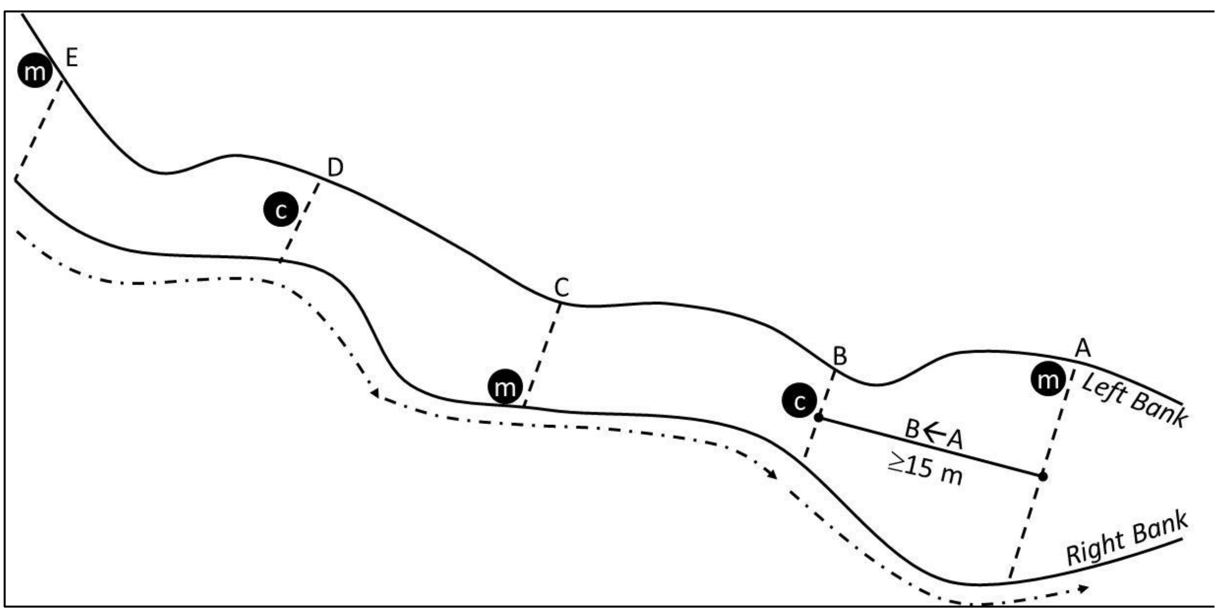

Figure 3: Diagram of the Margin-Center-Margin for collection of benthic macroinvertebrates and periphyton. Stream-flow direction is indicated by the dashed arrow lines parallel to the right bank.

ensures that multiple substrates and habitats are sampled in order to have a complete community representation of the reach. The subsamples for biological indicators collected at each transect are combined into one composite sample for BMI and one composite sample for periphyton.

3.5.1 Benthic Macroinvertebrates

To collect BMIs, firmly place the D-frame dipnet into the channel. In an area approximately 0.09 m^2 immediately upstream of the dipnet, agitate the substrate with hands and/or feet for one minute. Depending on the substrate, be sure to loosen cobbles to capture clinging BMIs. In sandy substrate, be conscientious not too sweep too much sand into the net. After agitating the substrate, sweep the dipnet upstream out of the water with the flow moving through the net. At this time, the crew member may remove any cobbles and/or sticks from the sample after inspecting for BMIs. Holding the dipnet out of the water, the crew member may splash water through the mesh from the outside to wash BMIs down into the sample and to rinse fine substrate out of the net. Once the sample has consolidated at the bottom of the dipnet, grab the bottom to hold the sample secure, and turn the dipnet inside out over the wide-mouth collection jar and deposit the sample into the jar. The jar should be no more than half full of 90% ethanol. Once the sample has been deposited in the jar, do a visual inspection of the dipnet and use the forceps to remove remaining BMIs. Use extra caution not to damage the body of the BMI as that may affect identification by the laboratory.

At each sampling point where BMIs are collected, determine if the habitat is a pool, glide, riffle or rapid. Record the dominant substrate type (fine/sand, gravel, coarse substrate (coarse gravel or larger) or other (e.g., bedrock, hardpan, wood, aquatic vegetation, etc.) and the habitat type (pool, glide, riffle, or rapid) for each sample collected on the Stream Survey Form, Section Sample Collection (Attachment A).

3.5.2 Periphyton

Close to the same location but not in the agitated area, collect the periphyton subsample. This can be accomplished in two ways. (Do not collect periphyton if the water is ≥0.5 m deep.)

The preferred method is that the crew member removes a cobble (small boulder or other submerged woody debris), places the item in the funnel which has been placed in the mouth of the 500 mL container. With the cobble in the resting in the funnel, place the delineator over the cobble’s surface that was exposed to the water-substrate interface in the stream and gently use the soft bristle brush to scrape the periphyton off of the rock within the delineator for one minute. Prior to removing the delineator, use a wash bottle with stream water to rinse the cobble and delineator into the 500 mL container. Return the cobble to the stream and rinse the brush with stream water into the container.

If the substrate is too small (course gravel and smaller), too large (bigger than a small boulder), bedrock or the like, or large woody material, a modified 60 mL syringe may be used to remove periphyton. Where possible, place the delineator on the item or in the substrate to maintain coverage area. Place the syringe inside the delineator and while pulling back on the plunger, move the syringe in a scrapping within the delineator motion to remove periphyton. Once the syringe is full, discharge 45 mL of the contents directly into the periphyton container. Crew members should use care in finer substrates as to gently scrape only from the surface and not penetrate into the substrate.

Each transect should have approximately 45 mL of sample collected for the overall composite sample. Place 500 mL container in a small, dark cooler with wet ice between transects.

3.6 Between Transect Habitat Assessments

Two methods may be used to assess between transects habitat of a stream reach: thalweg profile or an inter-transect profile. Depending on the protocol or ABP, one of these two methods may be used. The Coordinator will determine which prior to a bioassessment. Information is recorded on the Stream Survey Form, Section PHab Thalweg or Inter-Transect Profile and Woody Debris (Attachment A).

3.6.1 Thalweg Profile

The thalweg is the deepest part of a stream channel where a majority of the water is flowing. It may not necessarily be in the center of the channel. At equal distances between each transect (i.e. A to B) the thalweg is measured along with other stream morphology information. In streams where the X-site wetted width is less than 2.5 m, measure the thalweg every one meter for 15 measurements. If the wetted width is greater than 2.5 m but less than 3.75 m, measure the thalweg every 1.5 m for 10 measures for a 15 m transect. For reaches greater than 150 meters, the distance between each thalweg measurement is the total reach length divided by 10 (i.e., a 340 meter reach would be every 3.4 meters for a thalweg measurement between transects) for a total of 10 measurements. At each thalweg location, the crew member measures the water depth (cm), if soft sediment is present (Y or N), the channel unit code (Table 7), and whether or not a side channel or backwater is present (Y or N). The very first thalweg measurement (Station 0) is at the previous transect (i.e. A), and measured at ten or fifteen locations until the final station which is one-station length prior to the next transect (i.e. B). At Stations 0 and 5 or 7, wetted width and bar width, if a bar is present, are also measured. Additionally, at Station 5 or 7, the substrate is categorized at five locations across the channel (left, left-center, center, center right and right). Depth and embeddedness is not required at this cross-section. Station 7 is used for stream reaches with 15 one meter stations and Station 5 is used for stream reaches with ten stations ≥ 1.5 m stations.

3.6.2 Inter-Transect Profile

At one-half the distance between transects, wetted width (m) is measured and the substrate is categorized at 5 locations across the channel (left, left-center, center, center right and right). At each distance from the left bank, and including the left bank, four measurements will be obtained: (1) distance from the left bank, (2) water depth (cm) at each location, (3) substrate size classification (Table 4) and (4) percent embeddedness (Table 5). At each distance (left, left-center, center, right-center, and right) the crew member will measure the water depth (cm) with a measuring rod. Without feeling around, the crew member touches the channel bottom where the measurement was made to determine substrate size classification and estimates the percent embeddedness. For five substrate classifications, there is a pre-determined embeddedness. However, for the remaining size classes, embeddedness needs to be estimated as to how deep the substrate (cobble, boulder, etc.) is embedded in the channel bottom (Table 5).

At each inter-transect, identify the proportion of the different channel codes (Table 8) for flow habitat that compose the entire inter-transect. Record percentages to the nearest 5% where the total percentage must total 100% for the inter-transect.

Table 13: Channel code

Class (Code)	**Description**
Glide (GL)	Water moving slowly, with a smooth, unbroken surface. Low turbulence. Flow less than 0.3 m/s.
Riffle (RI)	Water moving, with small ripples, waves and eddies -- waves not breaking, surface tension not broken. Sound: babbling, gurgling.
Rapid (RA)	Water movement rapid and turbulent, surface with intermittent whitewater with breaking waves. Sound: continuous rushing, but not as loud as cascade.
Cascade (CA)	Water movement rapid and very turbulent over steep channel bottom. Much of the water surface is broken in short, irregular plunges, mostly whitewater. Sound: roaring.
Falls (FA)	Free falling water over a vertical or near vertical drop into plunge, water turbulent and white over high falls. Sound: from splash to roar.
Dry Channel (DR)	No water in the channel, or flow is submerged under the substrate (hyporheic flow).
Pools (PO)	Still water, low velocity, a smooth, glassy surface, usually deep compared to other parts of the channel.

3.7 Obtaining Slope and Bearing

Between each transect at the conclusion of the between transect habitat assessments (i.e., A to B), two crew members will measure slope and bearing (between each transect i.e., A to B). The slope and bearing should be measured as close to mid-channel as possible while being able to stand at the water's surface. If necessary, the crew members may stand on the bank to complete this task to ensure that they are measuring slope at the water's surface. One crew member will be at the new transect upstream (i.e. B) to sight downstream to the second crew member holding a stadia rod or other visible tall measuring rod (i.e. A). The first crew member's eye-height has been determined on the measuring rod. The second crew member returns to the previous transect downstream (i.e. A) to hold the measuring rod. The first crew member sights downstream utilizing a clinometer to the second crew member holding the measuring rod. Where the line in the clinometer levels against the eye-height on the downstream crew member's measuring rod will be the slope (%) between the two transects. The upstream crew member aligns a compass to the downstream crew member to obtain the bearing measurement. Bearing measurements are 0° to 359°. Crew members should stand mid-channel and may be in the water for bearing measurements. Should there be obstructions between transects that prohibit a full slope and bearing measurements between transects (vegetation, sharp meanders), distance between slopes can be broken up into no more than three supplemental subsections. Bearing cannot be measured overland, i.e., if there is a clear field of vision between two transects but the channel has sinuosity, the bearing must be broken up to account for the sinuosity. Bearing measurements are always over the channel. These supplemental subsections should be recorded accordingly.

In a large, less vegetated waterbody with a gentler slope, the surveyor's level may be used. After attaching to a tripod, the surveyor's level is leveled according to the manufacturer's recommendations, which is generally to adjust the three leveling feet of the base plate until the bubble is centered. Level is checked in all planes to be measured. If the level does not "self-level" in all measured planes, the user should check the instruction manual for suggested options. Elevation readings are made at each transect with a stadia rod and the difference between each elevation reading is recorded as the change in elevation. **NOTE: Multiple transect elevations can often be made for each setup of the level, but every time the tripod and level are moved a second measurement of the last transect elevation from the last setup is required. The crew member cannot use elevations from previous setups because the relative height of the level has changed.**

Slope and bearing information is recorded on the Stream Survey Form, Slope and Bearing Measurement (Attachment A).

3.8 Additional Stream Assessments

During the sampling, as crew members record data at each transect, they need to be aware of the watershed attributes for completion of additional stream assessments. At the conclusion of the sampling, a crew member will record torrent evidence, channel constraint, watershed assessment and any general comments.

3.8.1 Channel Constraint

At the conclusion of the sampling, crew members will identify reach-wide channel geomorphology. Attributes include the channel pattern, type of constraint, and associated features if applicable. Additionally, crew members will note the percentage of the stream that is in contact with the constraining feature. Channel constraint information is recorded on the Stream Survey Form, Section Channel Constraint (Attachment A).

3.8.2 Torrent Evidence

At the conclusion of the sampling, crew members will identify evidence of torrent scouring and deposits, if any, in the reach-wide channel geomorphology. Crew members may choose more than one feature as evidence. For example, a channel may have evidence of scouring due to riparian trees having fresh bark scars and/or heavy deposits of debris in the channel and along the banks. Torrent evidence information is recorded on the Stream Survey Form, Section Torrent Evidence Assessment (Attachment A).

3.8.3 Watershed Activities and Disturbances Observed

For the entire localized watershed within the field of vision of crew members, residential, recreational, agricultural, industrial, and stream management activities are observed and noted. Levels can be noted as low, moderate or heavy. Activities not noted by crew members are left blank to indicate not observed. Additionally, the waterbody character is ranked between pristine to highly disturbed and from appealing to unappealing. Crew members note any presence of beaver activities, and note the dominant land use (forest, agriculture, range, urban, or suburban/town). Weather conditions should be noted and recorded. This information is recorded on the Stream Survey Form, Section Watershed Assessment (Attachment A).

3.9 Stream Discharge

Stream discharge measurements are generally made at the conclusion of the sampling to avoid disruption to the stream channel. They are done at a chosen optimal cross-section (but not necessarily at any transect). Two methods are outlined for obtaining stream discharge measurements: a velocity area procedure utilizing a velocity meter and the neutrally buoyant object method. Additionally, stream discharge may be obtained from a United States Geological Survey (USGS) gage if one is within the immediate area.

Stream discharge information is recorded on the Stream Survey Form, Section Discharge Measurement (Attachment A).

3.9.1 Velocity-Area Procedure

Discharge measurements are made at only one chosen channel cross-section within the sampling reach. It is important to choose a channel cross-section that is uniform in depth and free from natural and artificial obstructions. For example, a glide area with a “U” shaped channel cross-section that is free of obstructions provides the best conditions for measuring discharge by the velocity-area method. Crew members may remove debris and obstructions if necessary.

Geomorphological characteristics best suited for selecting a location include:

- Segment of stream above and below selected location is straight.

- Depths mostly greater than 15 cm; however, do not measure discharge in a pool.
- Flow is relatively uniform, with no eddies, backwaters, or excessive turbulence.
- "U" shaped, with a uniform streambed free of large boulders, woody debris or brush, and dense aquatic vegetation.

To set-up the location, first lay the stadia rod or measuring tape across the stream perpendicular to its flow, with the "zero" end of the rod or tape on the left bank. Where possible, divide the total wetted stream width into 15 to 20 equal-sized intervals. To determine interval width, divide the width by 20 and round to a convenient number. Intervals should not be less than 10 cm wide, even if this results in less than 15 intervals. The first interval is located at the left margin of the stream (left when looking downstream), and the last interval is located at the right margin of the stream (right when looking downstream). A crew member will stand downstream of the stadia rod, to the side of the first interval point (closest to the left bank if looking downstream), and downstream of the propeller to avoid disrupting the stream flow. Adjust the position of the probe on the wading rod so it is at 0.6^{th} of the measured depth below the surface of the water. This is the depth where the average velocity occurs. Crew members should wait 20 seconds to allow the meter to equilibrate, and then measure the velocity. Repeat this at every interval on the cross-section.

3.9.2 Neutrally Buoyant Object Method

In very small, shallow streams where the velocity-area cannot be utilized, the neutrally buoyant object method is used obtain an estimate of discharge. The velocity is estimated by measuring the time it takes for a neutrally buoyant object to travel through a measured length of the channel. The channel cross-sectional area is determined from a series of depth measurements along one or more channel cross-sections.

Examples of suitable neutrally buoyant float objects include plastic balls (with holes), small whiffle balls, small sponge rubber balls or small sticks. The object must float low in the water. It should also be small enough that it does not "run aground" or drag bottom. Generally with a 5 to 10 meter reach, crew members select three cross-sections (upper, middle, and lower) to represent the channel dimensions within the segment. Select a segment of the sampling reach that is deep enough to float the object freely and long enough that it will take at least 30 seconds for the object to travel the selected reach. If required, increase the distance of the flow reach to achieve at least 30 seconds of float time. Determine the stream depth at 5 equally spaced points at each cross-section. Drop float object above the start area to allow object to reach stream velocity. Three separate times, a crew member will measure the time (seconds) elapsed for the object to travel through the segment that includes all of the selected cross-sections.

3.9.3 United States Geological Survey Gage

Throughout Nevada, there are many active United States Geological Survey (USGS) gages. Should a gage be within a reasonable distance of the sampling site, crew members may choose to find the Q-value from the USGS website rather than physically measuring discharge. Depending on the size of the watershed, a gage within 0.5 miles of the sampling reach will be an acceptable source of discharge values. A larger river may have a gage further from the sampling site which would be within a reasonable distance to record the discharge. The Coordinator and/or crew members may make an on-the-ground determination as to the suitability of utilizing a known USGS gage for discharge.

3.10 Periphyton and Chlorophyll-*a* Preservation

At the conclusion of the sampling, the periphyton sample needs to be preserved for taxonomic identification of diatoms and soft bodied algae and filtered for chlorophyll-*a* if applicable. Clean graduated cylinders and filtering apparatus are important as not to cross-contaminate the sample from a previous stream. Therefore, all equipment should be thoroughly washed following sample preservation, and rinsed with DI water prior to each use.

3.10.1 Periphyton Preservation

The crew member will glove-up prior to preserving the periphyton sample. To preserve a periphyton sample, agitate the 500 mL periphyton container to homogenize the sample. Record the total amount of the composite sample and number of transects collected on the stream survey form. Pour 45 mL of the composite sample into a 50 mL centrifuge tube. Preserve the sample with 2 mL of 10% neutral buffered formalin, label with site, date and total amount of original periphyton composite sample. The sample can be preserved in the laboratory following a sample event provided that the centrifuge tube has been placed in a plastic bag and held on wet ice. Once the sample has been preserved, the centrifuge tube should be sealed with electrical tape. **Note: When using formalin, use personal protective equipment (gloves, eye wear) and only in a well ventilated area preferably under a fume hood if in the laboratory. Do not allow skin or eye contact with the preservative.**

3.10.2 Chlorophyll-*a* Processing

If applicable, from the remainder of the composite periphyton sample, filter for chlorophyll-*a* using a clean water filtering apparatus that has been rinsed with deionized (DI) water. With clean forceps, a crew member should place a GF/F filter on the filter holder grid side up and carefully place the receiving chamber onto the holder using care not to tear the filter. A few drops of DI water can be used to hold the filter in place on the filter holder. Crew members need to be careful to record the amount measured out from the main sample for filtering.

Depending on the amount of periphyton in the sample (i.e., the clarity of the sample), the receiving chamber may be refilled repeatedly during the filtering process. If the sample appears to have abundant periphyton, crew members may start off filtering in 100 mL increments. Under no circumstances should any water remain in the receiving chamber after each filtering attempt. Once the sample has been filtered, the crew member using clean forceps gently removes the filter, folds in half and places the filter in an aluminum foil square. The filter is then placed in a centrifuge tube, labeled with the site, date, total amount of sample filtered, total composite amount and immediately placed in a plastic bag and stored on wet ice.

3.11 Decontamination

At the conclusion of each bioassessment, all equipment and gear exposed to the water must be decontaminated between sites to reduce the risk of transferring aquatic invasive species (AIS). Species of primary concern in the State include Eurasian watermilfoil (*Myriophyllum spicatum*), zebra and quagga mussels (*Dreissena polymorpha, D. rostriformis bugensis*), New Zealand mud snails (*Potamopyrgus antipodarum*), *Didymosphenia geminata* (commonly known as didymo or rock snot), *Myxobolus cerebralis* (sporozoan parasite that causes salmonid whirling disease), and *Batrachochytrium dendrobatidis* (a chytrid fungus that threatens amphibian populations).

Crew members must use a scrub brush to remove all mud, vegetation, and other debris from equipment. At this point, on-site water can be used to rinse after removal. Thereafter, all non-sensitive equipment, i.e., stadia rods, measuring rods, periphyton collection equipment, should be sprayed directly with a 10% bleach solution. Equipment should be fully extended where possible to ensure that all surfaces are being decontaminated. Sensitive equipment, i.e., waders, D-frame dipnets, etc., should be decontaminated with a spray of standard white vinegar. The multi-parameter sonde can be wiped down with a bleach cloth and the actual probe may be gently misted with 10% bleach solution and immediately rinsed with DI water prior to storage. Crew members need to finish by cleaning brushes and other equipment used for decontamination. Personal protective equipment should be used to protect against exposure of decontamination solution into the face, eyes and other exposed, sensitive areas.

In the event of sampling a stream with known AIS, that site should be scheduled at the week's end. Thereafter, equipment should be decontaminated on-site and a secondary decontamination and air-drying occurring at the base site with a 50% solution of Antibacterial Formula 409 with quaternary ammonia. Crew members also need to be vigilant for the presence AIS during bioassessments, and report suspected occurrences to the Nevada Department of Wildlife, Aquatic Invasive Species Coordinator, in addition to BWQP supervisors and staff.

3.12 Field Data Quality Control

During each bioassessment, a field lead will be randomly selected. This crew member is responsible for ensuring the completion of all data forms and/or fields, proper labeling of sample bottles and other maintenance as required. The field lead will communicate with the Coordinator any issues that need attention such as ordering/replacement of supplies, repairs and other crew needs.

3.13 Health and Safety Considerations

Sampling sites may be in extremely remote locations throughout the State. It is the responsibility of the Coordinator to ensure that field vehicles are in good working condition and equipped with two spare tires, shovel, ax and other supplies. Crew members are expected to have a current driver's license; however, skills in off-road driving, changing tires and checking fluids will be taught where necessary. Prior to the initiation of the field season, crew members take a defensive driving course offered by the State.

All crew members are offered the opportunity to take a CPR/First Aid course offered by the State prior to the initiation of the field season. In addition to sampling equipment, each bioassessment site kit is equipped with a first aid kit. Should supplies from a first aid kit be utilized, the kit is resupplied prior to the next site visit. Crew members who have unique medical concerns (i.e., insect stings, diabetes, etc.) must provide his or her own medical supplies to address such concerns. Additionally, crew members should confidentially notify the Coordinator and/or the Supervisor, WQSAM of his or her conditions in case of an emergency. Medical conditions are not an exclusion to seasonal employment with the Program. Crew members are expected to understand the conditions of working for extended periods outdoors and be prepared with sunscreen, water, insect repellant and other supplies necessary for them to complete his or her assignment in the conditions present.

Occasionally, weather in Nevada may represent hazardous conditions. In the event of thunder and lightning storms, crew members need to evacuate the site as quickly and safely as possible. Flash floods may occur during heavy rain events and affect downstream areas where precipitation did not fall. Summer temperatures in Nevada may exceed 100 °F and will not necessarily preclude bioassessments. The field lead will make a determination based on conditions as to proceed with a bioassessment during adverse weather conditions.

Wildlife, poisonous snakes and arachnids may be encountered during a bioassessment. For the most part, these animals will move away from human activity. Do not attempt to remove or frighten a poisonous snake from the site area. It is better to skip a transect than to engage a potential wildlife threat.

Dry, hot summers are common in Nevada, and wildland fires can occur. Field vehicles should always be parked in designated parking areas where available or on barren soil – never park where dry grass may ignite beneath a hot vehicle. Ensure that field vehicles are equipped with fire extinguishers.

While it is unlikely, there have been occurrences of illegal marijuana cultivation in remote Nevada locations. Generally, these sites are associated with streams and rivers where the water is withdrawn for the cultivation. Should crew members encounter such a site and/or people associated at such a site, they should leave the area as quickly and safely as possible. Once the crew members are removed from the area, they should contact the Coordinator or other representative of BWQP and the local law enforcement agency to report the location of the activities.

Additional guidelines can be found in NDEP BWQP's Quality Assurance Program Plan for Surface Water Sampling Appendix B: Health and Safety Plan.

Chain of Custody Benthic Macroinvertebrate Samples

Shipped From:
Bureau of Water Quality Planning
901 S. Stewart Street, Suite 4001
Carson City, Nevada 89701
Marianne Denton, Bioassessment Coordinator
dentonm@ndep.nv.gov
775-687-9457

Shipped To:
Watershed Assessment Associates
28 Yates Street
Schenectady, New York 12305
J. Kelly Nolan
jkn@rwaa.us
518-346-0225

Site	Collection Date	Site ID	Number of Jars	Protocol	Field Preservative
Truckee River	8/15/12	TRK01TruckeeWR3	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Truckee River	8/15/12	TRK01TruckeeWR4	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Truckee River	8/13/12	TRK01TruckeeWR5	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Truckee River	8/14/12	TRK01TruckeeWR6	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Truckee River	8/14/12	TRK01TruckeeWR7	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Maggie Creek	8/7/12	HUM02Maggie-2	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Sherman Creek	8/22/12	HUM02Sherman-1	2 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Susie Creek	8/7/12	HUM02Susie-2	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Burns Creek (lower)	7/31/12	SN03BurnsLower	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Burns Creek (upper)	7/31/12	SN03BurnsUpper	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Snow Canyon Creek (low)	7/31/12	SN03SnowCanyonLow	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Snow Canyon Creek (upper)	7/31/12	SN03SnowCanyonUpper	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Steamboat Creek	7/6/12	STBT01Steamboat2A	2 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Alum Creek	8/29/12	TRK02Alum-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Chalk Creek	8/30/12	TRK02Chalk-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Hunter Creek	7/5/12	TRK02Hunter-2	2 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Sweetwater Creek (low)	7/26/12	WALK02SwWater-Low	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Rough Creek	8/28/12	p-NVW04485-090	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Chiatovich Creek/Ref NV-379814	7/25/12	CEN04Chiat-2	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Trail Canyon Creek/Ref NV0375117	7/25/12	CEN04Trail-2	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Lamoille Creek (Upper)	8/22/12	HUM02Lamoille-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Soldier Creek/Ref EPA 01-0121	8/8/12	HUM02Soldier-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Dorsey Creek	8/1/12	SN03Doprsey-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol

Walker Gulch	8/1/12	SN03WalkerGulch	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Thomas Creek	7/2/12	STBT03Thomas-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Whites Creek (Upper)	7/24/12	STBT03Whites-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Sweetwater Creek (Upper)	7/26/12	WALK02SwWater-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Ash Canyon Tributary	8/16/12	p-NVW04485-085	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Desert Creek (Upper)	8/27/12	p-NVW04485-093	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Smith Creek	8/21/12	p-NVW04485-1053	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
E.F. Carson River	8/16/12	CAR02EFkCarson-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Mill Creek (above mine)	8/22/12	SN03RTMillUpper	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol
Pie (below confluence of Pie & Gance)	8/22/12	HUM03Pie-1	1 ✓	Stream Habitat/Composite NRSA Protocol	95% ethanol

Samples Relinguished by: [signature] Name — Date 12.7.12

Samples Received by: J Kelly Nolan Name — 12/19/12 Date

Samples Relinguished by: Name — Date

Figure 4: Completed Benthic Macroinvertebrate Chain of Custody (COC) form.

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NEVADA STREAM VERIFICATION

SITE ID:		Visit:	O1 O2	Date:	__ __ /__ __ /__ __ __ __
NAME:		Site Type(s):	O Basin O Probabilistic O Repeat O Impaired O Reference O Other:____________		

GPS NAD 83	Latitude	Longitude	Location	Elevation	Verified By
	__ __ .__ __ __ __ __	-__ __ __.__ __ __ __ __	O X-Site O Other:_____	________(m)	O GPS O Map Atlas O Topo Map O Signs O Other:__________

Basin	City	County	Ecoregion IV	HUC

Directions to the Site

Sampleable	Non-Sampleable		
O Fully Wadeable O Partial wadeable (>50% of reach sampled) O Altered – Channel but does not match map O Dry – modified	O Dry – visited O Dry -- permanently O Dry – not visited O Not wadeable	O Impounded – explain in comments O Wetland O Map Error – no water body ever present O Other (explain in comments)	O Access permission denied O Permanently inaccessible O Temporarily inaccessible

Channel Width to Determine Reach (m)	Upstream Length (m)	Downstream Length (m)	Total Reach (m)	Comments

Thalweg Station Information

- For widths ≤ 2.5 m, establish stations every 1 m (150 total). Inter-Transect Profile at Station 7.
- For widths > 2.5 and ≤3.5 m, establish stations every 1.5 m (100 total). Inter-Transect Profile at Station 5.
- For widths > 3.5 m, establish stations at increments equal to 0.01 times the reach length (100 total). Inter-Transect Profile at Station 5.

Thalweg Station Distance (m)	Total Number of Thalweg Stations	Inter-Transect Profile	
		O5	O7

General Comments

Field Crew			

NEVADA FIELD MEASUREMENT

Site ID:		**Date**:	__ __ /__ __ /__ __ __ __

FIELD MEASUREMENT		**Flag**	**Comments**
Location	O X-Site O Other:_____		
Time (military)	___ ___ :___ ___		
Air Temperature T °C = (T °F - 32) × 0.56	O °F O °C		
Water Temperature (°C)			
DO (mg/L)			
DO Saturation (%)			
pH			
Conductivity (µS/cm)			

ROUTINE CHEMISTRY		**Flag**			**Flag**
Location	O X-Site O Other:_____		**Date/Time of Delivery**		
Time (military)	___ ___ :___ ___				
Routine Pollution	O Collected O Not Collected		**Total Recoverable Metals**	O Collected O Not Collected	
Preserved Routine Pollution	O Collected O Not Collected		**Dissolved Metals**	O Collected O Not Collected	
Bacteria	O Collected O Not Collected		**Other**	O Collected O Not Collected	

CALIBRATION INFORMATION					**Flag**
Probe instrument model:					
Probe ID:					
Calibration Date:					
Temperature	Sensor (°C)		Thermometer (°C)		
DO	Elevation (m)		Calibration Value	O mg/L O %	
	Barometric Pressure (mm Hg)		Displayed Value	O mg/L O %	
pH	Manufacturer				
	Calibration Value		Calibration Value		
	Displayed Value		Displayed Value		
Conductivity	Manufacturer				
	Calibration Value		Calibration Value		
	Displayed Value		Displayed Value		

Flag	**Comments**

Flag Codes: K = No measurement or observation made. U = Suspect measurement or observation. F1, F2, etc. = misc. flags assigned. Explain all flags in comment section.

NEVADA SAMPLE COLLECTION

Site ID:		Date:	__ __ /__ __ /__ __ __ __

BENTHIC MACROINVERTEBRATE TRANSECTS

Number of Jars		Number of Transects		Preserved	O Yes O No

Substrate Codes = S.C.	Channel Codes = C.C.	Margin-Center-Margin Code
Fine/Sand = F Gravel = G Coarse = C Other = OT (flag and explain)	Pool = P Glide = GL Riffle = RI Rapid = RA	Left = L Center = C Right = R

A		B		C		D		E		F		G		H		I		J		K	
S.C.	C.C.	S.C.	C.C.	S.C.	C.C.	S.C.	C.C.	S.C.	C.C.	S.C.	C.C.	S.C.	C.C.	S.C.	C.C.	S.C.	C.C.	S.C.	C.C.	S.C.	C.C.
F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P
G	GL	G	GL	G	GL	G	GL	G	GL	G	GL	G	GL	G	GL	G	GL	G	GL	G	GL
C	RI	C	RI	C	RI	C	RI	C	RI	C	RI	C	RI	C	RI	C	RI	C	RI	C	RI
OT	RA	OT	RA	OT	RA	OT	RA	OT	RA	OT	RA	OT	RA	OT	RA	OT	RA	OT	RA	OT	RA
Flag		Flag		Flag		Flag		Flag		Flag		Flag		Flag		Flag		Flag		Flag	

A			B			C			D			E			F			G			H			I			J			K		
L	C	R	L	C	R	L	C	R	L	C	R	L	C	R	L	C	R	L	C	R	L	C	R	L	C	R	L	C	R	L	C	R
Flag			Flag			Flag			Flag			Flag			Flag			Flag			Flag			Flag			Flag			Flag		

COMPOSITE PERIPHYTON

Composite Volume (mL)		Sample Volume (mL)		# of Transects		Preserved?	O Formalin O Glutaraldehyde	_____ mL

Flag	Comments

Flag Codes: K = No measurement or observation made. U = Suspect measurement or observation. F1, F2, etc. = misc. flags assigned. Explain all flags in comment section.

NEVADA CHANNEL CONSTRAINT

Site ID:		Date:	__ __ /__ __ /__ __ __ __

CHANNEL PATTERN (select one):

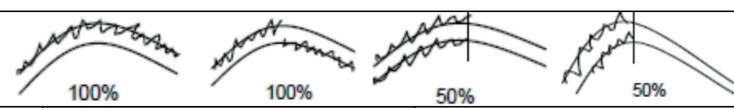
- ○ One channel
- ○ Anastomosing (complex) channel: Relatively long major and minor channels branching and rejoining.
- ○ Braided channel: multiple short channels branching and rejoining – mainly one channel broken up by numerous mid-channel bars.

CHANNEL CONSTRAINT (select one):

- ○ Channel is very constrained in a V-shaped valley. It is very unlikely to spread out over valley or erode a new channel during flood.
- ○ Channel is in a Broad Valley but channel movement by erosion during floods is constrained by incision. Flood flows do not commonly spread over valley floor or into multiple channels.
- ○ Channel is in a Narrow Valley, but is not very constrained. Limited in movement by relatively narrow valley floor (<~10× bankfull width.
- ○ Channel is Unconstrained in Broad Valley. During flood it can fill off-channel areas and side channels, spread out over flood plain, or easily cut new channels by erosion.

CONSTRAINING FEATURES (select one):

- ○ Bedrock: channel is in a bedrock-dominated gorge.
- ○ Hillslope: channel constrained in narrow V-shaped valley.
- ○ Terrace: channel is constrained by its own incision into river/stream gravel/soil deposits.
- ○ Human bank alterations: constrained by rip-rap, wall, landfill, dike, road, etc.
- ○ No constraining features.

Percent of channel length in contact with constraining feature.	______ 0 – 100%	

Average bankfull width (m)		Valley width (m) (visual estimated average)	

General Comments

NEVADA TORRENT EVIDENCE ASSESSMENT

Site ID:		Date:	__ __ /__ __ /__ __ __ __

EVIDENCE OF TORRENT SCOURING (select all that apply):

- ○ Stream channel has a recently devegetated corridor two or more times the width of the low flow channel. This corridor lacks riparian vegetation with possible exception of even-aged woody shrubs/saplings seedlings, grasses or other herbaceous plants.
- ○ Stream substrate cobbles or large gravel particles are NOT IMBRICATED. Imbricated means that they lie with flat sides horizontal and stacked. In torrent scour, stones are laying in unorganized patterns and are not "water-worn."
- ○ Channel has little evidence of pool-riffle structure, i.e., you could ride a mountain bike down the channel.
- ○ The channel is scoured down to bedrock for substantial portion of the reach.
- ○ There are gravel or cobble berms ABOVE bankfull level.
- ○ Downstream of scoured reach, there are massive deposits of sediment, logs and other debris.
- ○ Riparian trees have fresh bark scars at many points along the stream at heights far above the channel bed.
- ○ Riparian trees have fallen into the channel as a result of scouring near their roots.

EVIDENCE OF TORRENT DEPOSITS (select all that apply):

- ○ There are massive deposits of sediment, logs, and other debris in the reach. This may contain wood and boulders that could not have been moved by the stream even at extreme flood stage.
- ○ If the stream has begun to erode newly laid deposits, it is evident that these deposits are "MATRIX SUPPORTED." This means that the large particles, like boulders and cobbles, are often not touching, but have silt, sand and other fine particles between the larger substrate particles.

NO EVIDENCE

- ○ No evidence of torrent scouring or torrent deposits.

General Comments

NEVADA WATERSHED ASSESSMENT

Site ID:		**Date:**	__ __ /__ __ /__ __ __ __

WATERSHED ACTIVITIES AND DISTURBANCES
(Intensity: Blank=Not observed, L=Low, M=Moderate, H=Heavy)

Blank field indicates absence ○

Residential		Recreational		Agricultural		Industrial		Stream Management	
L M H	Residences	L M H	Hiking Trails	L M H	Cropland	L M H	Industrial Plants	L M H	Liming
L M H	Maintained Lawns	L M H	Parks, Campgrounds	L M H	Pasture	L M H	Mines Quarries	L M H	Chemical Treatment
L M H	Construction	L M H	Primitive Camp/Park	L M H	Livestock Use	L M H	Oil Gas Wells	L M H	Angling Pressure
L M H	Pipes Drains	L M H	Trash Litter	L M H	Orchards	L M H	Power Plants	L M H	Dredging
L M H	Dumping	L M H	Surface Films, Scum	L M H	Poultry	L M H	Logging	L M H	Channelization
L M H	Roads			L M H	Feedlot	L M H	Evidence of Fire	L M H	Water Level Fluctuations
L M H	Bridges Causeways			L M H	Water Withdrawal	L M H	Odors	L M H	Fish Stocking
L M H	Sewage Treatment					L M H	Commercial	L M H	Dams

SITE CHARACTERISTICS (200 m radius)

Waterbody Character

Pristine: ○5 ○4 ○3 ○2 ○1 Highly Disturbed

Appealing: ○5 ○4 ○3 ○2 ○1 Unappealing

Beaver

Signs: ○ Absent ○ Rare ○ Common

Flow Modification: ○ None ○ Minor ○ Major

Dominant Land Use

○ Forest	○ Agriculture	○ Range	○ Urban	○ Suburban, Town

If forest, age class ○ 0 – 25 yrs. ○ 25 – 75 yrs. ○ >75 yrs.

Weather

Conditions, Observations and Local Contacts

NEVADA DISCHARGE MEASUREMENT

Site ID:		Date:	__ __ /__ __ /__ __ __ __

VELOCITY AREA (m/s)

	Distance from Bank (cm)	Depth (cm)	Velocity (m/sec)	Flag		Distance from Bank (cm)	Depth (cm)	Velocity	Flag
1	0				11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

NEUTRAL BUOYANT OBJECT

	Float 1	Float 2	Float 3
Distance (m) >5 m			
Float Time (s)			
Flag			

Cross Sections on Float Reach		Upper	Middle	Lower
Width (m)				
Depth (cm)	L			
	LC			
	C			
	RC			
	R			

Q VALUE

Q Value		○cfs ○m^3/s	USGS Gage ID		Approximate distance from reach (m)		Flag	

Flag	Comments

Flag Codes: K = No measurement or observation made. U = Suspect measurement or observation. F1, F2, etc. = misc. flags assigned. Explain all flags in comment section.

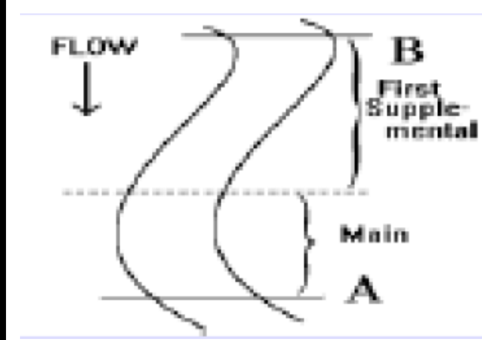
NEVADA SLOPE & BEARING MEASUREMENT

Site ID:		Date:	__ __ /__ __ /__ __ __ __

MAIN (always used)				FIRST SUPPLEMENTAL			SECOND SUPPLEMENTAL				Method	○ CL ○ TR	
Transect	Slope/Elv.	Bearing 0 – 359	Proportion %	Slope/Elv	Bearing 0 – 359	Proportion %	Slope/Elv	Bearing 0 – 359	Proportion %	Flag	Tran.	Height (m, cm)	Difference
A < B											A		
B < C											A < B		(B-A)
C < D											B < C		(C-B)
D < E											C < D		(D-C)
E < F											D < E		(E-D)
F < G											E < F		(F-E)
G < H											F < G		(G-F)
H < I											G < H		(H-G)
I < J											H < I		(I-H)
J < K											I < J		(J-I)
											J < K		(K-J)
											K		

Flag	Comments

Flag Codes: K = No measurement or observation made. U = Suspect measurement or observation. F1, F2, etc. = misc. flags assigned. Explain all flags in comment section.



NEVADA PHAB CHANNEL/RIPARIAN CROSS-SECTION

Site ID:		Date:	__ __ /__ __ /__ __ __ __	Transcent	○A ○B ○C ○D ○E ○F ○G ○H ○I ○J ○K ○ Extra side channel

SUBSTRATE CROSS-SECTIONAL

	Dist (m)	Depth (cm)	Size Class	Embed. 0-100%	Flag
Left	0				
LCtr					
Ctr					
RCtr					
Right					

Substrate Size Class Codes	Emb %
RS = Bedrock Smooth (larger than car)	0
RR = Bedrock Rough (larger than car)	0
RC = Concrete/Asphalt	
XB = Larger Boulder (meterstick to car)	
SB = Small Boulder (basketball to meterstick)	
CB = Cobble (tennis ball to basketball)	
GC = Coarse Gravel (marble to tennis ball)	
GF = Fine Gravel (ladybug to marble)	
SA = Sand (gritty up to ladybug size)	100
FN = Fines (slit, clay, muck – not gritty)	100
HP = Hardpan (firm, consolidated fine substrate)	0
WD = Wood (any size)	
OT = Other (This includes vegetative and organic material. Root masses would be considered 100% embedded.)	

FISH COVER/OTHER

0= Absent (0%) 1=Sparse (<10%) 2=Moderate (10-40%) 3=Heavy (40-75%) 4=Very heavy (>75%)

	Channel Cover	Flag
Filamentous Algae	0 1 2 3 4	
Macrophytes	0 1 2 3 4	
BIG Woody Debris (>0.3 m)	0 1 2 3 4	
SMALL Woody Debris (<0.3 m)	0 1 2 3 4	
Live Tree or Roots	0 1 2 3 4	
Overhanging Veg. ≤1 m of surface	0 1 2 3 4	
Undercut Banks	0 1 2 3 4	
Boulders	0 1 2 3 4	
Artificial Structures	0 1 2 3 4	

VISUAL RIPARIAN ESTIMATES

D=Deciduous C=Coniferous E=Broadleaf Evergreen M=Mixed N=None

Riparian Vegetative Cover	Left Bank	Flag	Right Bank	Flag
Canopy (>5 m high)				
Woody Vegetation	D C E M N		D C E M N	
BIG Trees (>0.3 m DBH)	0 1 2 3 4		0 1 2 3 4	
SMALL Trees (<0.3 m DBH)	0 1 2 3 4		0 1 2 3 4	
Understory (0.5 - 5 m high)				
Woody Vegetation	D C E M N		D C E M N	
Woody Shrubs & Saplings	0 1 2 3 4		0 1 2 3 4	
Non-Woody Grasses, Forbs	0 1 2 3 4		0 1 2 3 4	
Ground Cover (<0.5 m high)				
Woody Shrubs & Saplings	0 1 2 3 4		0 1 2 3 4	
Non-Woody Grasses, Forbs	0 1 2 3 4		0 1 2 3 4	
Barren, Bare Dirt or Duff	0 1 2 3 4		0 1 2 3 4	
Human Influence 0=Not present P=>10 m C=w/i 10 m B=on bank				
Wall, Rip-rap, Dam, Revetment	0 P C B		0 P C B	
Buildings	0 P C B		0 P C B	
Pavement/ Lot	0 P C B		0 P C B	
Pipes (in- / outflow)	0 P C B		0 P C B	
Road / Railroad	0 P C B		0 P C B	
Landfill / Trash	0 P C B		0 P C B	
Park / Lawn	0 P C B		0 P C B	
Row Crops	0 P C B		0 P C B	
Pasture, Range Hay Field	0 P C B		0 P C B	
Logging Operations	0 P C B		0 P C B	
Mining Activity	0 P C B		0 P C B	

BANK MEASUREMENTS

	Bank Angle (°)	Undercut Dist. (cm)	Flag
Left			
Right			
Wetted Width (m)			
Bar Width (m)			
Bankfull Width (m)			
Bankfull Height (m)			
Incised Height (m)			

CANOPY COVER MEASUREMENTS

Densiometer (0-17)			
CenUp		CenR	
CenL		Left	
CenDown		Right	

Flag	Comments	Flag	Comments

Flag Codes: K = No measurement or observation made. U = Suspect measurement or observation. F1, F2, etc. = misc. flags assigned. Explain all flags in comment section.

NEVADA PHAB THALWEG or INTER-TRANSECT PROFILE & WOODY DEBRIS

Site ID:		Date:	__ __/__ __/__ __ __ __	Transect	○A-B ○B-C ○C-D ○D-E ○E-F ○F-G ○G-H ○H-I ○I-J ○J-K

THALWEG

	Thalweg Depth (cm)	Wetted Width (m)	Bar Width		Channel Code	If No, leave blank.			Flag
			Present	Width (m)		Soft Sediment	Side Channel	Back Water	
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									

Channel Codes: PO=pool GL=glide RI=riffle RA=rapid CA=cascade FA=falls DR=dry

INTER-TRANSECT

	Dist (m)	Depth (cm)	Size Class	Embed. 0-100%	Flag
Left	0				
LCtr					
Ctr					
RCtr					
Right					

FLOW HABITATS (% between transects = 100%)

Channel Type	Percentage (%)
Riffle	
Rapid	
Glide	
Pool	
Cascade	
Falls	
Dry	
Other (describe)	

SUBSTRATE

		LFT	LCTR	CTR	RCTR	RGT	Flag
Station: 5 or 7							

Flag	Comments

LARGE WOODY DEBRIS Fill in if unmarked boxes are zero ○

Diameter	Pieces in Bankfull Channel			Pieces Above Bankfull Channel		
	1.5 – 5 m	5 – 15 m	>15 m	1.5 – 5 m	5 – 15 m	>15 m
0.1<0.3 m						
0.3 – 0.6 m						
0.6 – 0.8 m						
>0.8 m						

Flag Codes: K = No measurement or observation made. U = Suspect measurement or observation. F1, F2, etc. = misc. flags assigned. Explain all flags in comment section.

NEVADA BIOASSESSMENT FIELD AUDIT

Field Auditor		
Evaluation Date		
Stream Name		
Field Crew		
Others Present		

BASE SITE ACTIVITIES

Site Information

Is the GPS unit set for NAD83?	☐Y	☐N	☐N/A
Are the coordinates set to decimal degrees and are the measurements in metric?	☐Y	☐N	☐N/A
Did the site packet include site directions, topographic maps and aerial images?	☐Y	☐N	☐N/A
Is there access permission letters included? Was the landowner notified of date?	☐Y	☐N	☐N/A
Are appropriate Chain of Custody forms included with the site packet?	☐Y	☐N	☐N/A
Are Scientific Collection Permits valid and on-site?	☐Y	☐N	☐N/A

Pre-Sampling Preparedness

Was the multi-parameter probe calibrated for pH and conductivity on site?	☐Y	☐N	☐N/A
Was the multi-parameter probe calibrated for DO on site based on barometric pressure and/or elevation?	☐Y	☐N	☐N/A
Has the multi-parameter probe been serviced since the previous field season by an authorized service specialist?	☐Y	☐N	☐N/A
Were calibration values recorded appropriately on the Stream Survey Form?	☐Y	☐N	☐N/A
Is there sufficient wet and/or dry ice to preserve samples?	☐Y	☐N	☐N/A
Is there 95% ethanol for BMI preservation?	☐Y	☐N	☐N/A
Is there 10% neutral buffered formalin for periphyton preservation?	☐Y	☐N	☐N/A
Is the sampling equipment clean, functional and organized?	☐Y	☐N	☐N/A
Are there appropriate back-up supplies (batteries, etc.)?	☐Y	☐N	☐N/A

Notes

STREAM VERIFICATION			
Site Verification			
Does the site meet target specifications?	☐Y	☐N	☐N/A
If not, was an alternate site available?	☐Y	☐N	☐N/A
Was the x-site located and the GPS coordinates recorded?	☐Y	☐N	☐N/A
Was elevation recorded?	☐Y	☐N	☐N/A
Was wetted width measured and recorded?	☐Y	☐N	☐N/A
Defining Reach			
Was the stream reach length appropriate for wetted width?	☐Y	☐N	☐N/A
Was the reach laid out with minimal disturbance to the stream?	☐Y	☐N	☐N/A
Were flags placed at the transects and inter-transects?	☐Y	☐N	☐N/A
X-SITE SAMPLING			
***In-Situ* Measurements**			
Was the multi-parameter probe placed mid-channel and allowed to stabilize for five minutes prior to measurement recording?	☐Y	☐N	☐N/A
Were all the parameters obtained?	☐Y	☐N	☐N/A
If not, were there explanations for values not obtained?	☐Y	☐N	☐N/A
Was collection time recorded?	☐Y	☐N	☐N/A
Was ambient air temperature recorded?	☐Y	☐N	☐N/A
Were all *in-situ* values recorded in the Stream Survey Form?	☐Y	☐N	☐N/A
Water Chemistry Measurements			
Did the crew member glove up prior to water collection?	☐Y	☐N	☐N/A
Were the water collection bottles appropriately labeled?	☐Y	☐N	☐N/A
Were the appropriate water collection bottles rinsed three times prior to collection?	☐Y	☐N	☐N/A
Was the rinse water discarded downstream from the collection site?	☐Y	☐N	☐N/A
Did the collection of water interfere with the multi-parameter probe?	☐Y	☐N	☐N/A
Were samples preserved appropriately?	☐Y	☐N	☐N/A
Was the fecal bacteria bottle double bagged prior to placement on wet ice?	☐Y	☐N	☐N/A
Was water chemistry information recorded in the Stream Survey Form?	☐Y	☐N	☐N/A
Notes			

PHYSICAL HABITAT CHANNEL/RIPARIAN CROSS-SECTION			
Bank Characteristics			
Did the crew work in an upstream direction?	☐Y	☐N	☐N/A
If side channels were present, did the crew know the protocol for addressing side channels?	☐Y	☐N	☐N/A
Was the wetted width measured and recorded?	☐Y	☐N	☐N/A
If present, were bars measured and recorded, and included in the wetted width?	☐Y	☐N	☐N/A
Did the crew know the distinction between a bar and an island?	☐Y	☐N	☐N/A
Was the bankfull width determined accurately and measured and recorded?	☐Y	☐N	☐N/A
Was the bankfull height measured and recorded from the water's surface to the intersection of bankfull width?	☐Y	☐N	☐N/A
Was incised height located and measured or estimated and recorded?	☐Y	☐N	☐N/A
Was the bank angle measured or estimated and recorded for each bank?	☐Y	☐N	☐N/A
Was undercut measured and recorded for each bank?	☐Y	☐N	☐N/A
Substrate Size and Channel Dimensions			
Did the crew start from the left bank?	☐Y	☐N	☐N/A
Was the wetted width divided by four to locate the substrate and depth measurement points?	☐Y	☐N	☐N/A
Were the distances from the left bank recorded for each measurement point?	☐Y	☐N	☐N/A
Was the depth recorded at each measurement point with a measuring rod?	☐Y	☐N	☐N/A
Was the substrate size class recorded at each measurement point?	☐Y	☐N	☐N/A
Was the percent substrate embeddedness recorded at each measurement point?	☐Y	☐N	☐N/A
Canopy Density			
Was the densiometer modified correctly for measurements?	☐Y	☐N	☐N/A
Did the crew member stand mid-channel to measure the four canopy density values (upstream, left, downstream, right) and each bank?	☐Y	☐N	☐N/A
Did the crew member hold the densiometer 0.3 m above the water's surface?	☐Y	☐N	☐N/A
Did the crew member move around and hold the densiometer with their face below the V?	☐Y	☐N	☐N/A
Were all the values recorded in the Stream Survey Form?	☐Y	☐N	☐N/A
Fish Cover			
Was the amount of fish cover determined 5 m up- and downstream from the transect?	☐Y	☐N	☐N/A
Were all the values recorded in the Stream Survey Form?	☐Y	☐N	☐N/A

Riparian Vegetation Types and Structure			
Did the crew member estimate 5 m up- and downstream and 10 m back from each bank?	☐Y	☐N	☐N/A
Were the dominant vegetation type and coverage estimated and record for each of the three layers: canopy, understory and ground cover?	☐Y	☐N	☐N/A
Were both banks measured and recorded?	☐Y	☐N	☐N/A
Human Influence			
Did the crew member estimate 5 m up- and downstream and 10 m back from each bank?	☐Y	☐N	☐N/A
Did the crew member determine each influence as to its proximity to the stream and record appropriately (not present, present, close or on bank)?	☐Y	☐N	☐N/A
Did the crew member make sure NOT to sight through another transect?	☐Y	☐N	☐N/A
Were both banks measured and recorded?	☐Y	☐N	☐N/A
Notes			

BIOLOGICAL INDICATORS			
Sample Collection			
Was the margin-center-margin method utilized for both BMIs and periphyton?	☐Y	☐N	☐N/A
Was the collection location 1 m upstream of the cross-section?	☐Y	☐N	☐N/A
Were channel characteristics and substrate type recorded on the Stream Survey Form?	☐Y	☐N	☐N/A
Benthic Macroinvertebrates			
Was a D-frame dipnet properly placed facing upstream with the flow moving through?	☐Y	☐N	☐N/A
Was the substrate disturbed for 1 minute in an area 0.09 m^2 upstream of the net?	☐Y	☐N	☐N/A
Was the net removed from the stream in a sweeping upstream motion?	☐Y	☐N	☐N/A
Was large substrate and woody debris inspected for organisms and removed from the net?	☐Y	☐N	☐N/A
Was the net washed/splashed from the outside to rinse organisms into the sample?	☐Y	☐N	☐N/A
Was the sample transferred from the net into a collection bottle with 95% ethanol for a composite sample?	☐Y	☐N	☐N/A
Was the net inspected for any remaining organisms and were those organisms removed carefully as to not damage for identification purposes?	☐Y	☐N	☐N/A
Was the appropriate number of sample jars used for the composite sample (i.e., no more than 50% sample per jar)? Were the sample jars appropriately labeled?	☐Y	☐N	☐N/A
Were the total number of transects recorded on the Stream Survey Form?	☐Y	☐N	☐N/A
Periphyton			
Was periphyton collected from substrate that was < 0.5 m deep?	☐Y	☐N	☐N/A
Was the delimiter used to define the area for periphyton sampling?	☐Y	☐N	☐N/A
Where possible, was the substrate (cobble, wood) removed, placed in a funnel over a 500 mL bottle, and gently scrubbed for 1 minute to remove periphyton?	☐Y	☐N	☐N/A
Were the substrate, funnel and scrubber rinsed with stream water into the 500 mL bottle with no more than 45 mL for a composite sample?	☐Y	☐N	☐N/A
If necessary, was periphyton collected using a 60 mL syringe within the delimiter (for fine/sandy or large immobile substrates)?	☐Y	☐N	☐N/A
Was the 500 mL bottle placed on ice in a dark cooler between transects?	☐Y	☐N	☐N/A
Was the total volume of the composite sample recorded on the Stream Survey Form?	☐Y	☐N	☐N/A
Was the composite sample homogenized, measured to 45 mL and preserved with 2 mL of 10% neutral buffered formalin in a 50 mL centrifuge tube?	☐Y	☐N	☐N/A
Was the total volume of the composite sample recorded on the Stream Survey Form?	☐Y	☐N	☐N/A
Notes			

BETWEEN TRANSECTS			
Profile			
Was it determined prior to sampling whether or not the thalweg depth profile or inter-transect profile would be measured?	☐Y	☐N	☐N/A
Thalweg Depth Profile			
Were the thalweg depth stations laid out based on the wetted width?	☐Y	☐N	☐N/A
Was the thalweg depth measured and recorded at the deepest location in the stream where a majority of the water was flowing?	☐Y	☐N	☐N/A
Was a measuring rod used to measure the depth of the thalweg?	☐Y	☐N	☐N/A
At the 0 station, was the wetted width measured and recorded?	☐Y	☐N	☐N/A
At the 0 station, was a bar noted and measured and recorded?	☐Y	☐N	☐N/A
At each thalweg depth station, was the presence soft substrate noted and recorded?	☐Y	☐N	☐N/A
At each thalweg depth station, was the presence of a side channel noted and recorded?	☐Y	☐N	☐N/A
At each thalweg depth station, was the presence of backwater noted and recorded?	☐Y	☐N	☐N/A
At each thalweg depth station, was the channel code noted and recorded?	☐Y	☐N	☐N/A
At either the 5 or 7 station, was the wetted width measured and recorded?	☐Y	☐N	☐N/A
At either the 5 or 7 station, was the substrate characterized at five locations across the channel (left, left center, center, right center and right)?	☐Y	☐N	☐N/A
At either the 5 or 7 station, was a bar noted, measured and recorded?	☐Y	☐N	☐N/A
Inter-Transect Profile			
Was the wetted width divided by four to locate the substrate and depth measurement points?	☐Y	☐N	☐N/A
Were the distances from the left bank recorded for each measurement point?	☐Y	☐N	☐N/A
Was the depth recorded at each measurement point with a measuring rod?	☐Y	☐N	☐N/A
Was the substrate size class recorded at each measurement point?	☐Y	☐N	☐N/A
Was the percent substrate embeddedness recorded at each measurement point?	☐Y	☐N	☐N/A
Was the percent of flow habitat between transects observed and recorded?	☐Y	☐N	☐N/A
Large Woody Debris (LWD)			
Did the crew know how to determine LWD?	☐Y	☐N	☐N/A
Were the observations of LWD recorded as “in” or “above bankfull?”	☐Y	☐N	☐N/A
Were these values recorded on the Stream Survey Form?	☐Y	☐N	☐N/A
Notes			

SLOPE AND BEARING			
Equipment			
Was it determined prior to sampling whether a surveyors' level or clinometer would be utilized?	☐Y	☐N	☐N/A
Was this recorded on the Stream Survey Form?	☐Y	☐N	☐N/A
Surveyors' Level			
Had the level been calibrated prior to the field season?	☐Y	☐N	☐N/A
Was the level set in an area that had clear field of view for all transects?	☐Y	☐N	☐N/A
Was the base plate leveled by checking the bubbles?	☐Y	☐N	☐N/A
If slope could not be determined in one measurement between transects, were supplemental transects used and percentage of reach recorded?	☐Y	☐N	☐N/A
If the level was moved mid-measurements, was the base plate re-leveled?	☐Y	☐N	☐N/A
If the level was moved mid-measurements, were new between transect measurements made and recorded?	☐Y	☐N	☐N/A
Was the height observed on the stadia rod recorded and the difference between transects determined?	☐Y	☐N	☐N/A
Was the stadia rod held by the secondary crew member at water's surface?	☐Y	☐N	☐N/A
Clinometer			
Was the eye level of the reading crew member noted on the stadia rod being held by the secondary crew member?	☐Y	☐N	☐N/A
Were the measurements made looking downstream?	☐Y	☐N	☐N/A
Were the measurements made and recorded in percentages?	☐Y	☐N	☐N/A
Was the stadia rod held by the secondary crew member at water's surface?	☐Y	☐N	☐N/A
If slope could not be determined in one measurement between transects, were supplemental transects used and percentage of reach recorded?	☐Y	☐N	☐N/A
Bearing			
Did the crew member stand mid-channel and determine if they could see the mid-channel downstream	☐Y	☐N	☐N/A
Were the bearing measurements made looking downstream?	☐Y	☐N	☐N/A
Was the bearing recorded in degrees?	☐Y	☐N	☐N/A
If slope could not be determined in one measurement between transects, were supplemental transects used and percentage of reach recorded?	☐Y	☐N	☐N/A
Notes			

DISCHARGE			
Equipment			
Was it determined which method would be used (velocity area, neutral buoyant object or nearby stream gage)?	☐Y	☐N	☐N/A
Velocity Area			
Was a cross section of the reach located that best represented flow of the stream?	☐Y	☐N	☐N/A
Was the wetted width measured and divided into 15 – 20 equal sections, none less than 10 cm?	☐Y	☐N	☐N/A
Was the propeller wading rod placed in the stream and adjusted to 0.6 of the depth?	☐Y	☐N	☐N/A
Did the crew member stand downstream of the propeller?	☐Y	☐N	☐N/A
Did the crew member wait at least 20 seconds before measuring and recording the velocity?	☐Y	☐N	☐N/A
Was the velocity recorded as meters per second?	☐Y	☐N	☐N/A
Was a “Z” noted on the Stream Survey Form after the last velocity measurement?	☐Y	☐N	☐N/A
Neutral Buoyant Object			
Was a float length selected that the object would travel for at least 30 seconds?	☐Y	☐N	☐N/A
Were width and depth profiles measured and recorded at the upper, middle and lower sections of the float length?	☐Y	☐N	☐N/A
Was the float time determined with a stopwatch?	☐Y	☐N	☐N/A
Was the float time measured and recorded three times?	☐Y	☐N	☐N/A
If slope could not be determined in one measurement between transects, were supplemental transects used and percentage of reach recorded?	☐Y	☐N	☐N/A
Stream Gage			
Was a stream gage identified within close proximity to the site prior to sampling?	☐Y	☐N	☐N/A
Was the distance from the gage to the site determined?	☐Y	☐N	☐N/A
Will the Q-value from the gage be obtained on the date and time of the sampling?	☐Y	☐N	☐N/A
Notes			

GENERAL STREAM ASSESSMENT			
Channel Constraint			
Was the channel pattern observed and recorded?	☐Y	☐N	☐N/A
Was the type of channel constraint identified and recorded?	☐Y	☐N	☐N/A
Was the predominant constraining feature determined and recorded?	☐Y	☐N	☐N/A
Was the percent of channel constraint noted and recorded?	☐Y	☐N	☐N/A
Was the average bankfull width and valley width visually estimated and recorded?	☐Y	☐N	☐N/A
Evidence of Torrent Scouring			
Was evidence of torrent scouring noted and recorded?	☐Y	☐N	☐N/A
Were torrent deposits noted and recorded?	☐Y	☐N	☐N/A
Watershed Assessment			
Were watershed activities and disturbances noted and recorded appropriately (low, moderate, heavy)?	☐Y	☐N	☐N/A
Was the stream character assessed and recorded?	☐Y	☐N	☐N/A
Were signs of beaver activity and modifications noted and recorded?	☐Y	☐N	☐N/A
Was the dominant land use noted and recorded?	☐Y	☐N	☐N/A
Notes			

FINAL STREAM ACTIVITIES			
Decontamination			
Was all mud and debris scrubbed from equipment?	☐Y	☐N	☐N/A
Was all of the equipment that came into contact with water decontaminated with a solution of 10% bleach?	☐Y	☐N	☐N/A
Was sensitive material decontaminated with vinegar (i.e., d-frame dipnets)?	☐Y	☐N	☐N/A
After decontamination, was all equipment rinsed with tap water?	☐Y	☐N	☐N/A
Is there a plan for reporting evidence of aquatic invasive species?	☐Y	☐N	☐N/A
Data Forms			
Did a crew member review all data forms for completeness and follow-up with other crew members to ensure that all data fields were completed?	☐Y	☐N	☐N/A
Were sample bottles double checked for label completeness?	☐Y	☐N	☐N/A
Other			
Was all the equipment checked for damage?	☐Y	☐N	☐N/A
Were batteries replaced as necessary?	☐Y	☐N	☐N/A
Was the area cleaned up of any flagging in the stream channel, reach, trash in the work area, etc.?	☐Y	☐N	☐N/A
Notes			